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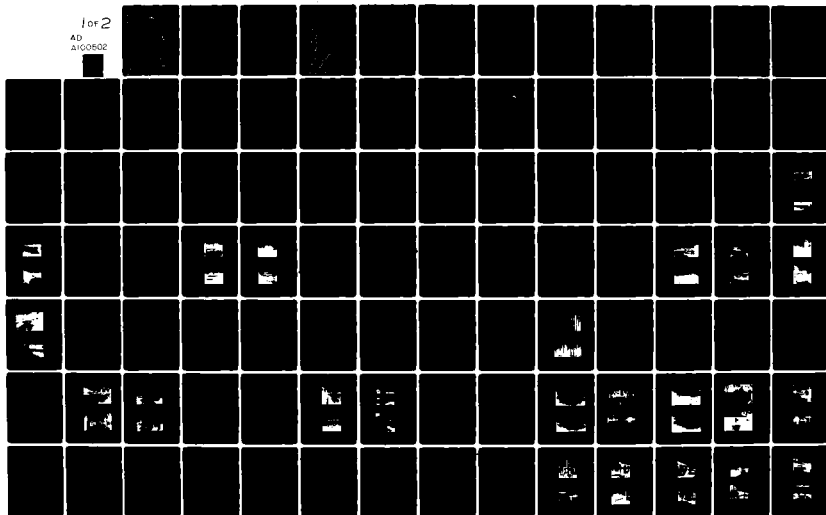
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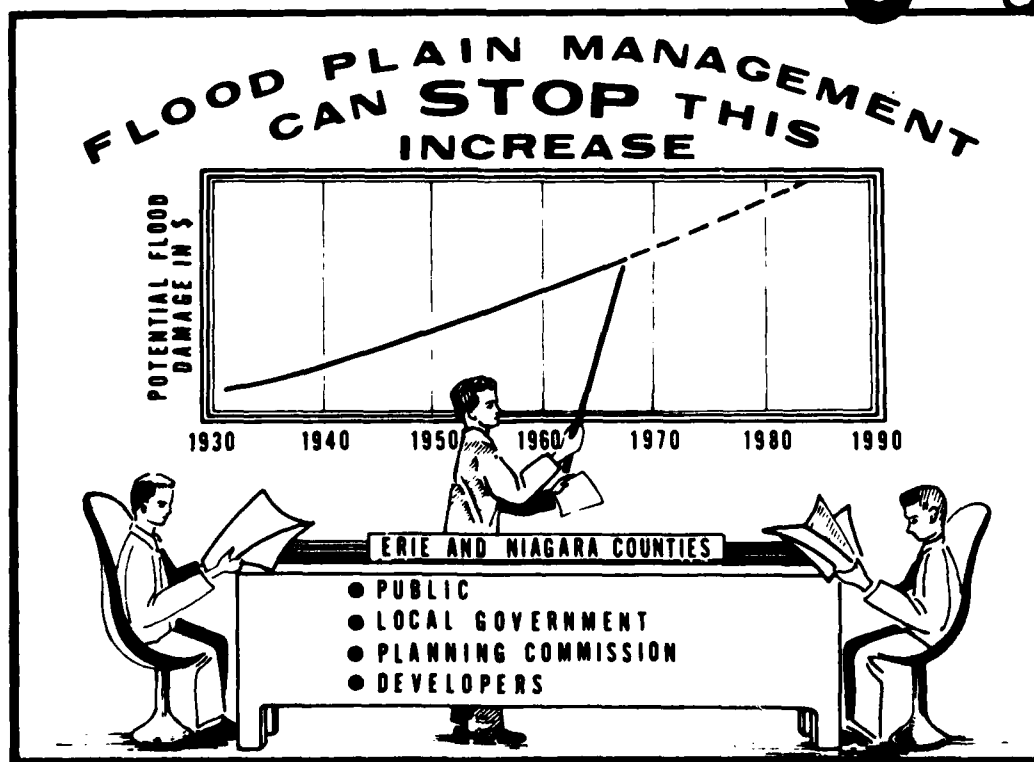
TONAWANDA CREEK AND ITS
AFFECTED TRIBUTARIES

ERIE AND NIAGARA COUNTIES

NEW YORK

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PREPARED FOR
ERIE AND NIAGARA COUNTIES
By

CORPS OF ENGINEERS, U.S. ARMY
BUFFALO DISTRICT

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Tonawanda Creek
Is Receding From
Its Record Crest

Tonawanda Creek Bursts Banks; Flooded Area Blocks Akron Rd.

Water Pours
Into Roads
Basements

Rain Forecast,
Adding to Peril

By DON BARRY
Melting snow and inter-
mittent rain last night
killed most West

Water Depth Attains
Three Feet In Spots

flood crest of swollen Tonawanda Creek splashed
across the bridge, Town of Royalton, as
sometime last night. Five
feet in

Renewed Flooding
Feared From Rain

Continued heavy rainfall fore-
cast for today may cause West-
ern New York streams, which
overflowed during the week,
nearly their banks again.

35 Families Are Stranded
By Niagara County Flood

Some Inundated Roads Re-opening After
Farms, Residential Areas Are Covered

CITY STREETS
Ralph C. Loomis
of streets, said
Mrs. Willis Tryloff, RD 2, Ak-
ron, reported that Fred Peters,
Bartel Rd., had to move his cows
to the Herman Bachr farm on
Lewis Rd. The animals were
knee deep in water in
barn

Niagara County areas
hit early today by rising
wanda Creek have the
of relief late today
that have inundated
of acres of farmland
residential areas.
Northern Erie
was inundated
wanda Creek
described by
worst since
Scores

Flood Peril Ends;
Alert in Amherst,
Other Points Off

Yesterday afternoon's
alert in the northern
part of the town of Amherst
ended last night.

Homes Isolated
As Creek Rises

Tonawanda Creek con-
tinued to rise slowly last night
flood waters over a
mile section in the
stead and into N
Several homes
adjoining Fletcher
93, north of A

Pictures

Water over
two to four
feet deep
"An
tion
said
the
ch

Area Flooding
North Clarence
Residents Claim
Worst In 40 Years

crew
with a
evacuate
On the Erie
creek, Knapp
wanda Creek,
er, Birdick,
Rapids Rd, w

Bad Washouts in County Roads
Reported, Creeks Still Rise

Damage of at Least \$10,000 Found So Far:
Tonawanda Creek Flooding Three Highways

damage of at least
to county roads and cul-
washouts was reported
County Highway

Newstead Families
Being Evacuated

Blvd., near Union Rd., Cl-
wagon, Borden Rd., south
on St. Fisher and Lang-
West Seneca
Several washouts occu-
Back Creek Rd. in the
Back Creek Rd. Tow-
Boston, Sheriff Rd.

FRONTISPIECE

County line in the township was
flooded by between three and
four feet of water in some sec-

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INTRODUCTION

This flood plain information report on Tonawanda, lower Ransom, Black and Mud Creeks within Erie and Niagara Counties, New York, has been prepared at the request of the Erie County Department of Public Works through the New York Department of Public Works and the New York State Water Resources Commission. It will be distributed to local interests through the Erie-Niagara Basin Regional Water Resources Planning and Development Board. It is intended to provide planners and local governments with technical information on the largest known floods of the past and gives data on possible future floods, known as the Intermediate Regional Flood and the Standard Project Flood. The Intermediate Regional Flood has a frequency of occurrence in the order of once in 100 years and was determined from a statistical analysis of known floods on Tonawanda Creek and its affected tributaries. The Standard Project Flood is a flood of rare occurrence and, on most streams, is considerably larger than any floods that have occurred in the past. However, it is strongly recommended that these possible future floods be considered when development within the flood plain is planned. Using these data as a guide, the planners and officials have a basis for effective and workable legislation for the control of land use within the flood plain.

It is also directed toward present and prospective residents in and adjacent to the affected area of Tonawanda Creek. In order for flood plain regulations to receive the necessary public support, it is important that residents know the past history of flooding, the purposes and benefits of flood plain management and the ways that regulations can be coordinated with an over-all plan of development for the area.

The report is based on hydrological facts, historical and recent flood heights, and other technical data bearing upon the occurrence and magnitude of floods in the Tonawanda Creek area.

Included in this report are maps, profiles and cross sections which indicate the extent of flooding that has been experienced and that which might occur in the future. These data, if properly used, can be very beneficial in wise flood plain management. From the maps, profiles and cross sections in this report the depth of probable flooding at any location by a recurrence of one of the past floods or by the future occurrence of either the Intermediate Regional Flood or the Standard Project Flood may be learned. Based on this information, future construction may be planned high enough to avoid flood damage or, if at lower elevations, with recognition of the chances and hazards of flooding that are being taken.

This report does not include plans for the solution of flood problems. Rather, it is intended to provide the basis for further study and planning on the part of local governments within the study area in arriving at solutions to minimize future flood damages. This can be accomplished by local planning programs to guide developments by controlling the type of use made of the flood plain through zoning and subdivision regulations. Another way in which local flood plain management can be accomplished is through public acquisition for a low development use such as recreation.

The Buffalo District of the Corps of Engineers will, upon request, provide technical assistance to Federal, State and local agencies in the interpretation and use of the information contained within this report and will provide other available flood data related thereto.

SUMMARY OF FLOOD SITUATION

This flood plain information study covers the inundated areas along Tonawanda Creek and its affected tributaries from its confluence with the Niagara River to the easterly limit of Erie and Niagara Counties, New York (See plate 1). For ready identification the upstream limit of the study has been taken as the Hopkins Road bridge located approximately 41.5 creek miles from the Niagara River and 0.7 mile east of the Erie-Niagara and Genesee County boundary line.

On the right bank or predominantly the north side of Tonawanda Creek, the study area includes portions of the city of North Tonawanda and the towns of Wheatfield, Pendleton, Lockport and Royalton, all within Niagara County. During high stages, flood waters from Tonawanda Creek enter the Mud Creek basin via the overland route, causing flooding along the 18-mile length of tributary.

On the left bank or predominantly the south side of Tonawanda Creek, the study area includes portions of the city of Tonawanda and the towns of Tonawanda, Amherst, Clarence and Newstead, all within Erie County. At high stages, flood waters from Tonawanda Creek near mile 23.3 reverse flow in Beeman Creek and overtop Route 268, locally known as Salt Road. These waters then enter the Black Creek and Ransom Creek basin, causing widespread flooding along the 11-mile length of tributaries.

Along with information on Tonawanda Creek, data will also be given for the following areas directly affected by flooding from Tonawanda Creek; Mud Creek within Niagara County and lower Ransom Creek and Black Creek within Erie County.

The U. S. Geological Survey maintained an automatic water-stage recorder from August 1955 to September 1965 at Rapids, New York. This gage, located at Goodrich Road near mile 18.7, has been of little value in flood discharge investigations because of the large amount of discharge which bypasses the gage location by means of the overland flooding into

Black Creek and Mud Creek. The U.S. Geological Survey has also maintained a crest stage gage and wire weight gage since October 1955 and an automatic recording gage since October 1965 at Hopkins Road, Alabama, New York, near creek mile 41.5. The crest gage indicates the maximum stage reached during any given flood by means of a line of burnt cork powder on a calibrated stick within an enclosed pipe. The wire weight gage is manually operated and indicates the creek stage when the weight attached to the end of a thin cable touches the water surface. The New York State Department of Public Works has maintained a staff gage at the Hopkins Road location since 1922. There are no significant records of stream flow for Black, Ransom or Mud Creeks. Residents along the streams have been interviewed to determine high water marks. Newspaper files and historical documents were searched for information concerning past floods. From these data and studies of possible future floods on Tonawanda, Black, Ransom and Mud Creeks, local flood situation, both past and future, has been developed. The following paragraphs summarize the significant findings which are discussed in more detail in succeeding sections of this report.

* * *

THE GREATEST FLOODS Historical documents state the greatest floods in the study area occurred in March 1865 and again equalled in March 1904. It must be noted that at the time of these floods a dam was in existence upstream of the Main Street bridge in the city of Tonawanda near mile 0.3, thereby aggravating the flood situation upstream of this point. The dam was originally constructed as part of the Erie Canal in the spring of 1823. It raised the water level and eliminated deepening of the stream for canal use. It was estimated that the removal of the dam in 1918, along with modernization of the Barge Canal, lowered Tonawanda Creek about 6 feet.

* * *

ANOTHER GREAT FLOOD The greatest flood in recent years occurred during March and April 1960. Although other flood stages such as those which occurred in 1940 have exceeded the 1960 flood at some locations along lower Tonawanda Creek, the 1960 flood is still generally considered to be the most damaging flood because of its long duration and current development. Due to the length of duration above flood stage during the 1960 flood, Tonawanda Creek overflow into the Ransom - Black Creek basin and the Mud Creek basin caused record known stages and damages. However, due to the fact the dam in Tonawanda was removed in 1918 and the Erie Barge Canal improved, this flood caused only minor damage downstream of the Erie Barge Canal - Tonawanda Creek junction at mile 11.2. There is no doubt that if the Tonawanda dam was in existence at the time of the 1960 flood, catastrophic conditions would have resulted from that flood.

* * *

OTHER HISTORICAL FLOODS Severe floods occurred also in the Spring of 1889, 1893, 1894, 1896, 1902 and 1916. The summer floods of 1902 and 1903 were most disastrous to agricultural interests because they occurred just before the harvest season.

* * *

OTHER LARGE FLOODS The following dates have been recorded by newspaper articles and Corps of Engineer files as causing high water and damage to the lower Tonawanda Creek basin within recent years: March 1936, April 1940, March 1942, February 1954, December 1954-January 1955, March 1955, March 1956, January 1957 and January 1959.

* * *

KNOWN FLOOD STAGES Floods which have been recorded as the maximum, or near maximum of record upstream of the study area, have not necessarily been the maximum floods of record on Tonawanda Creek within the area covered by this report. This situation is due

principally to the size of the Tonawanda basin, and the fact that flood flows are greatly modified in the lower reaches by the abundant overbank storage provided by the wide flat flood plain.

* * *

INTERMEDIATE REGIONAL FLOOD The Intermediate Regional Floods for Tonawanda, lower Ransom, Black and Mud Creeks are floods that have an average frequency of occurrence in the order of once in 100 years. They are determined from an analysis of past floods and indicate the Intermediate Regional Flood along Tonawanda Creek to be from 1 to 2 feet higher than the 1960 flood. The Intermediate Regional Flood along lower Ransom and Black Creeks is estimated to be about 0.5 to 1.5 feet higher than the 1960 flood. On Mud Creek the Intermediate Regional Flood is estimated to be about 0.4 to 1.0 foot higher than the 1960 flood.

* * *

STANDARD PROJECT FLOOD The Standard Project Flood is a flood produced by the most severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the drainage basin under study. Hydrological determinations indicate that a flood of this magnitude could occur on Tonawanda Creek and in the city of Tonawanda would be about 8 feet higher than the 1960 flood, and at the upper end of the study area near Hopkins Road, approximately 2 feet higher than the 1960 flood. The Standard Project Flood in the Ransom - Black Creek reach could vary from about 6 feet above the 1960 flood at the confluence of Ransom and Tonawanda Creeks to less than 1 foot at Goodrich Road near mile 8.8. The Standard Project Flood in the Mud Creek reach could vary from approximately 5½ feet above the 1960 flood at Minnick Road near mile 2.4 to approximately 2 feet higher than the 1960 flood near Lewiston and Ditch Roads at mile 16.8.

* * *

FLOOD DAMAGES The recurrence of major known floods such as the 1865, 1904 and 1960 floods would cause substantial flood damages. It is estimated that over a period of years the average damage per year along both banks of Tonawanda Creek from mile 12.8 to mile 38.9 is \$33,700 for crop damage and \$101,700 for all other types of damage such as residential, commercial, public, highway and non-crop damage related to agriculture. The average annual damage for lower Ransom and Black Creeks is estimated to be \$10,200 for crop damage and \$45,500 for residential, commercial, public, highway and agricultural non-crop damage. The average annual damage for Mud Creek is estimated to be \$4,400 for crop damage and \$20,700 for residential, commercial, public, highway and agricultural non-crop damage. This amounts to a total of \$216,200 average annual damage for existing conditions at January 1967 price levels. An occurrence of the Intermediate Regional Flood or Standard Project Flood would cause extensive damage because of their wider extent, greater depth, higher velocity and the ever increasing development within the flood plain.

* * *

MAIN FLOOD SEASON The larger floods in the Tonawanda Creek watershed have often been caused by melting snow with moderate amounts of rainfall. Although damaging floods have occurred at all times of the year, almost all instances of major flooding have occurred in the late winter or early spring. Relatively few damaging floods have been produced by precipitation alone. This is due to the orientation of the watershed with respect to the usual direction of travel of frontal systems in this area. Tonawanda Creek below Batavia, as well as Ransom, Black and Mud Creeks, flow generally westward. Since the frontal systems normally travel from west to east, the peak runoff in the lower reaches occurs too early to be greatly reinforced by the peak runoff from the upper basin.

* * *

VELOCITIES OF WATER During high water periods channel velocities vary from 5.5 feet per second at Robinson Street near mile 3.7 to in excess of 10 feet per second at the Hopkins Road bridge. Velocities of flows over Goodrich Road in the Wolcottsburg area have been observed to be over 2 feet per second with a depth of less than 1 foot. During an Intermediate Regional Flood or a Standard Project Flood, velocities could be dangerous to life and property. Velocities greater than 3 feet per second combined with depths of 3 feet or greater are generally considered hazardous.

* * *

HAZARDOUS CONDITIONS The larger floods have caused hazards to local residents in many ways. Flood waters which overtop roads can cause hazardous driving conditions for anyone attempting to drive through the inundated areas. Due to the long duration of flooding, health problems often develop when septic tanks, and wells used for water supply systems become affected. The danger from underestimating the velocity and depth of flood waters by unsuspecting children is an age old problem confronting residents within the flooded areas.

* * *

FLOOD DAMAGE PREVENTION MEASURES There are no existing or authorized flood control projects within the study area. The Buffalo District, Corps of Engineers is presently preparing a report to determine the feasibility of possible flood control measures within the Tonawanda Creek basin. Considered plans of improvement include channel improvements or retardation of flood waters by means of retention pools or possibly a reservoir. At the present time, with the exception of the town of Royalton in Niagara County, none of the communities have flood plain regulations.

* * *

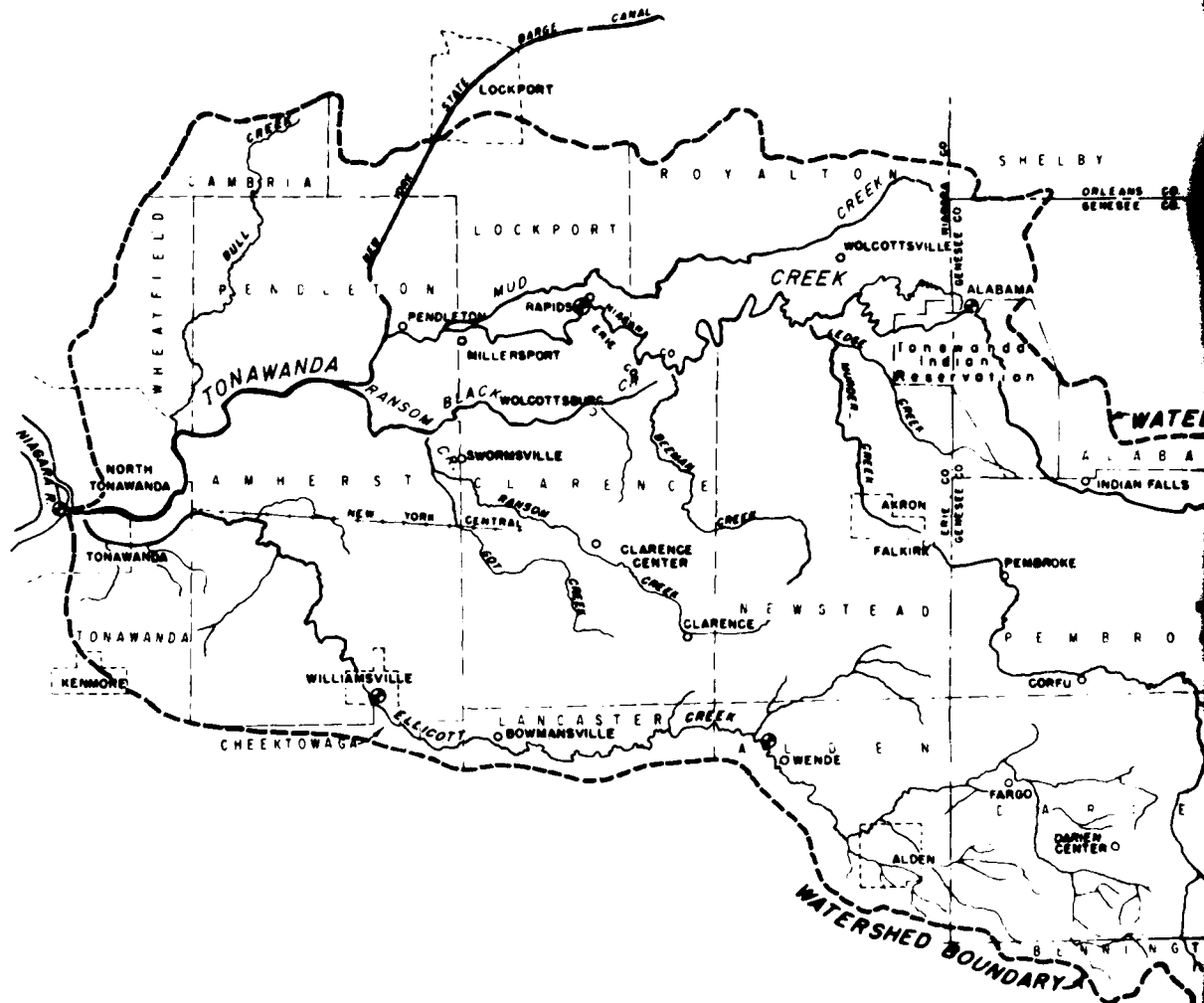
FUTURE FLOOD HEIGHTS Estimated flood crests that would be reached if either the Intermediate Regional Flood or the Standard Project Flood occurred in the study area are shown in table 1. The table gives a comparison of the Intermediate Regional Flood and the Standard Project Flood against the March - April 1960 flood, which is the highest flood in recent years. These data are prepared for the two U.S. Geological Survey gaging stations at Alabama and Rapids, New York so that future floods can more easily be compared with the past flood records shown in table 8 on page 43 and table 10 on page 48.

TABLE 1
RELATIVE FLOOD HEIGHTS

<u>Location</u>	<u>Mile above Mouth</u>	<u>Flood</u>	<u>Estimated Peak Discharge cfs</u>	<u>Above 1960 Flood feet</u>
U.S.G.S. Gage at Alabama, New York	41.5	March - April 1960	7,980	0
		Intermediate Regional	11,500	1.0
		Standard Project	35,200	1.7
U.S.G.S. Gage at Rapids, New York	18.7	March 1960	6,280 (1) 10,600 (2)	0
		Intermediate Regional	13,500 (2)	1.5
		Standard Project	50,000 (2)	2.7

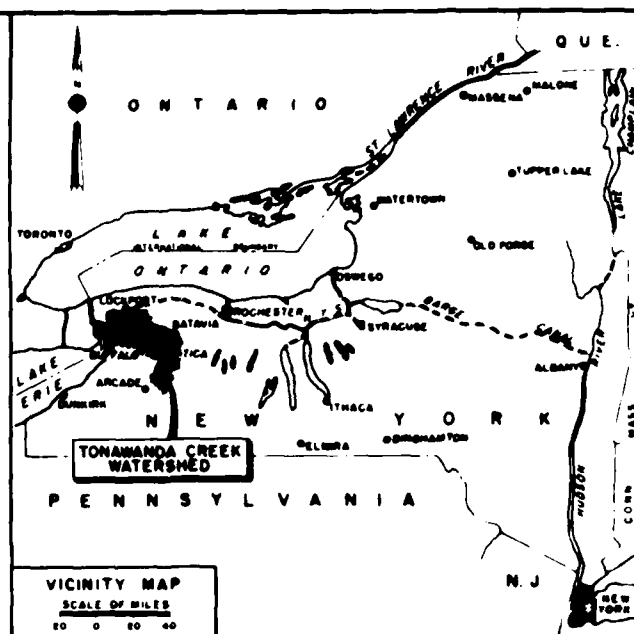
(1) Discharge past gage within channel

(2) Includes Tonawanda Creek overflow which bypasses the gage



 REACH COVERED BY THIS REPORT
 RECORDING GAGE

SCALE OF FEET
 0 5000 10000



TONAWANDA CREEK
ERIE & NIAGARA COUNTIES, N.Y.

TONAWANDA CREEK WATERSHED MAP

U.S. ARMY ENGINEER DISTRICT, BUFFALO 2

GENERAL CONDITIONS AND PAST FLOODS

GENERAL

This section of the report is a history of floods on Tonawanda Creek and its affected tributaries, Ransom Creek and Black Creek, in Erie County and Mud Creek in Niagara County, New York. The study area covers the lower 41.5 creek miles of Tonawanda Creek. Starting at the upper end of the study area, on the left or south bank, Tonawanda Creek flows along Erie County, including the Tonawanda Indian Reservation, the towns of Newstead, Clarence, Amherst, Tonawanda and the city of Tonawanda where it joins the Niagara River. On the right or north bank, Tonawanda Creek flows along Niagara County, including the Tonawanda Indian Reservation, the towns of Royalton, Lockport, Pendleton, Wheatfield and the city of North Tonawanda where it joins the Niagara River. The lower 40.8 creek miles of Tonawanda Creek serves as the border between Erie and Niagara Counties. The portion of Ransom Creek studied extends from its mouth, which is at mile 9.8 on Tonawanda Creek, upstream to its confluence with Black Creek, a distance of 3.8 creek miles and all within the town of Amherst. The investigation on Black Creek covers its entire length, starting at its mouth on the right bank of Ransom Creek in the town of Amherst, and extends upstream to its headwaters in the town of Clarence. The investigation on Mud Creek extends from its mouth, which is at mile 13.0 on Tonawanda Creek, upstream to the old Lewiston Road bridge, a distance of 16.85 creek miles. Mud Creek flows through the towns of Pendleton, Lockport and Royalton in Niagara County. Plate 1 and plates 5 through 7 of this report show the geographical orientation of Tonawanda Creek and its affected tributaries.

Tonawanda Creek flows generally from east to west in the reach covered by this report. Black Creek and the lower portion of Ransom Creek also flow generally westward to their confluence with Tonawanda Creek from the left bank. Mud Creek flows in a westerly direction toward its confluence with Tonawanda Creek from the right bank.

The principal flood problem areas in the lower Tonawanda basin are located between the Tonawanda Indian Reservation near mile 41.5 and the mouth of Ransom Creek near mile 9.8. Flooding is caused by overflow from the narrow, winding, obstructed channel of the main stream and complicated by overflow into similar channels of Mud Creek, Black Creek and the lower portion of Ransom Creek.

Since the lower 11.2 miles of Tonawanda Creek west of Pendleton form part of the New York State Barge Canal and have a navigable depth of 12 feet, little damage is caused by floods which are of a magnitude not greater than the 1960 flood. However, floods such as the Standard Project would cause an extremely large amount of flooding in an area which has not been flooded since the 1904 flood, which occurred before the N.Y.S. Barge Canal was improved. Even though the Intermediate Regional Flood and the Standard Project Flood are rare in occurrence they should be considered and weighed when planning new developments.

The first continuous record of stages on Tonawanda Creek began in 1922 at Hopkins Road, Alabama, New York, near mile 41.5, by the New York State Department of Public Works by means of a staff gage. The U.S. Geological Survey has been compiling stream data at this location since October 1955. The U.S. Geological Survey also maintained an automatic recording gage at Goodrich Road, Rapids, New York, near mile 18.7 from August 1955 to September 1965. The majority of information on past and future floods given in this report is based on the significant stream flow and stage data compiled at the Alabama and Rapids gage locations.

A search of the flood history on Tonawanda Creek has indicated frequent and extensive damage in the past and indicates damage will continue to increase because of increased development within the flood plain. Much of the flood data given in this report are based on reconnaissance made during or shortly after high water periods and on two surveys by the Corps of Engineers which were conducted to determine damages within most of the study area. In 1954 a thorough damage survey was carried out on the predominantly agricultural areas along

Tonawanda Creek between Hopkins Road, Alabama, N.Y., and the mouth of Ransom Creek. In 1962 this survey was updated by an examination of the additional development and changes in land use that had taken place since the 1954 survey. During these surveys local residents were interviewed and information was gathered pertaining to water elevations for various floods, damage suffered in the past and damage that could be expected during a recurrence of past floods or potential floods of greater magnitude. Through these field investigations an accurate profile for the largest recent flood, that of March - April 1950, has been developed for Tonawanda Creek, lower Ransom Creek, Black Creek and Mud Creek. A search was made of newspaper files, historical documents, gage records and other miscellaneous sources enabling a history of known floods to be developed for the study area dating back to 1865.

Because major floods along lower Ransom Creek, Black Creek and Mud Creek are directly affected by overflow of Tonawanda Creek, the flood history of the four streams is presented concurrently.

Settlement

Large scale settlement in the area of New York State occupied by the Lake Erie-Niagara River Drainage Basin was delayed until after 1797 by the presence of the Seneca Indians, who were the last hold-outs of the once powerful Iroquois Confederacy. By 1797 all basin land had been purchased except for a few small areas which the Senecas held for themselves. The Holland Land Company acquired lands in the basin and began land sales in 1801. The manager of the Holland Land Company laid out the basic system of roads and founded many towns including Buffalo. Despite the military activities along the Niagara Frontier during the war of 1812, the population of the Holland Project grew rapidly and had reached about 100,000 persons by 1821, most of which were in the Lake Erie - Niagara Drainage Basin.

The Erie Canal was opened to Buffalo in 1825 and the subsequent development of the northwestern portion of the basin was rapid. Buffalo became the great port of transfer for immigrants and manufactured goods from canal barge to lake vessel and of grain and other bulky produce from lake vessel to canal barge. By 1850, when the railroad reached the lake shore, Buffalo and its surroundings were well on the way to becoming a leading industrial area. During the subsequent period of industrial growth, general farming practices gave way to more specialized activities such as truck gardening, fruit growing and dairying.

On April 2, 1821, an act of the Legislature divided Niagara County and established the boundaries of the present Erie County. The geographical boundaries of townships within Erie County have not changed since 1857. The following is a list of the formation dates of political subdivisions within the Erie County study area.

- a. City of Tonawanda - Incorporated in 1903.
- b. Town of Tonawanda - Formed from Buffalo April 16, 1836
- c. Town of Amherst - Formed from Buffalo April 10, 1818, which included part of Cheektowaga at that time.
- d. Town of Clarence - Formed from Willink (now Aurora) March 11, 1808. At that time Clarence included Buffalo, which was taken off in 1810, Alden taken off in 1823 and Lancaster taken off in 1833.
- e. Town of Newstead - Formed from Town of Batavia as Town of Erie April 11, 1804; changed name April 18, 1831.

On March 11, 1808 Niagara County was formed from Genesee County lands. The following is a list of the formation dates of political subdivisions within the Niagara County area.

- a. City of North Tonawanda - Incorporated in 1897.
- b. Town of Wheatfield - Formed from Town of Niagara May 20, 1836.
- c. Town of Pendleton - Formed from Town of Niagara April 16, 1827.
- d. Town of Lockport - Formed from west part of Royalton and east part of Cambria February 2, 1824.
- e. Town of Royalton - Formed from south part of Hartland April 15, 1817.

Population

The U.S. Bureau of Census figures for 1966 show the population of the city of Buffalo has decreased from 532,759 in April 1960 to 481,453 in April of 1966, a drop of 9.6 percent in six years. During the same period, Erie County's population has increased to 1,087,183, showing a rise in some suburbs up to 34.8 percent. This trend of population moving from Buffalo to the Suburbs started early in the 1950's and is expected to continue.

The U.S. Bureau of Census figures for 1967 show the population of Niagara County has dropped 3.6 percent in the last seven years. These figures show that the populations of the cities of Niagara Falls and Lockport have decreased while the city of North Tonawanda and all the towns draining into Tonawanda Creek have increased. This further indicates the trend of suburban living and increased development within the flood plains. Figure 1 exemplifies the population trends for Erie and Niagara Counties and the city of Buffalo from 1900 to the present.

Between the period of 1920 and 1966 the population within Erie County for the area draining into Tonawanda Creek has increased from approximately 9,235 to approximately 58,117, representing an increase of 629.3 percent for the 46-year period. For the period between 1920 and 1967 the population within Niagara County for the area draining into Tonawanda Creek has increased from approximately 8,883 to approximately 24,119. This is equal to an increase of 271.5 percent for the 47-year period. The total for the portions of both counties in the Tonawanda Creek basin has increased from approximately 18,118 in 1920 to approximately 82,236 in 1967, representing an increase of 453.9 percent. Table 2 shows the increase of population for each community within the flood plain for the period 1920 thru 1966 in Erie County and 1920 thru 1967 in Niagara County.

The net result of the population trends within Erie and Niagara Counties shows a definite direction of increased development within the flood plain. This type of development will lead to future problems for its inhabitants due to increased overland flow and building in areas already flooded. Water surface elevations caused by stream encroachment will also increase unless proper Flood Plain Management is instituted and enforced as soon as possible.

Flood Damage Prevention Measures

The U.S. Army Corps of Engineers submitted a report to Congress pertaining to possible flood control measures for Tonawanda Creek and its tributaries on 7 February 1947. The report was subsequently published as Senate Document No. 46, 80th Congress, 1st Session and was the basis of authorization of the existing flood control project at Batavia, New York. The report was unfavorable with respect to flood protection improvements at other locations within the study area.

At the present time the Buffalo District, Corps of Engineers is engaged in a study entitled "Review of Reports For Flood Control And Allied Purposes On Tonawanda Creek And Tributaries, New York." Possible flood control measures being considered are channel improvements, levees, retention pools and a reservoir site. The results pertaining to justification of these plans of improvement along with recommendations are expected to be submitted to Congress early in 1968. Because justification for improvements is unknown at the present time and actual construction of flood preventative measures, if found to be feasible, would take several years, it is recommended local communities immediately develop and enforce flood plain regulations. It should be understood that flood control projects can not provide complete protection. They protect only against flooding up to the frequency found to be the most economically justified, which is the basis for design.

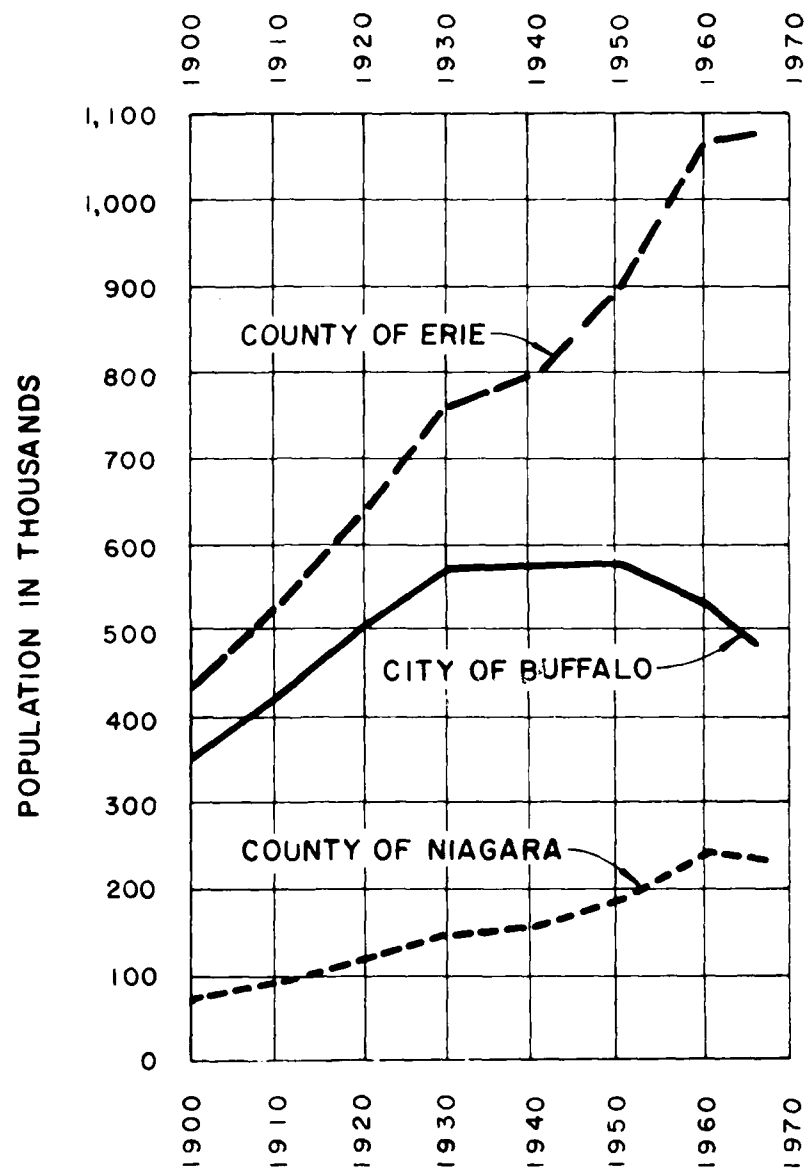


Figure 1

**POPULATION TRENDS
FOR THE COUNTIES OF ERIE AND NIAGARA
AND THE CITY OF BUFFALO**

TABLE 2 - POPULATION IN STUDY AREA

Erie County, New York

Name of Community	Percent of Community in Tonawanda Creek Basin	*	1920	1930	1940	1950	1960	1966
City of Tonawanda	5	A	10,068	12,681	13,008	14,617	21,561	21,946
		B	503	634	650	731	1,078	1,097
Town of Amherst	44	A	6,286	13,181	19,356	33,744	62,837	79,147
		B	2,766	5,800	8,517	14,847	27,648	34,825
Town of Clarence	94	A	2,660	3,208	4,426	6,331	13,267	17,001
		B	2,500	3,016	4,160	5,951	12,471	15,981
Town of Newstead	83	A	4,043	4,334	4,268	4,653	5,825	6,151
		B	3,356	3,597	3,542	3,862	4,835	5,105
Town of Tonawanda	1	A	5,505	25,006	32,155	55,270	105,032	109,702
		B	55	250	322	553	1,050	1,097
Tonawanda Indian Reservation	100	A	55	56	43	58	30	12
		B	55	56	43	58	30	12
Total estimated population for Tonawanda Creek basin within Erie County.			9,235	13,353	17,234	26,002	47,112	58,117

* A = Total population for each community.

B = Estimated population with Tonawanda Creek basin, assuming population is evenly distributed throughout each community.

TABLE 2 CONT'D. - POPULATION IN STUDY AREA

Niagara County, New York

Name of Community	Percent of Community in Tonawanda Creek Basin	*	1920	1930	1940	1950	1960	1967
City of North Tonawanda	25	A	15,482	19,019	20,254	24,731	34,757	35,783
		B	3,870	4,755	5,064	6,183	8,689	8,946
Town of Lockport	48	A	1,833	2,720	3,160	3,945	6,492	7,702
		B	880	1,306	1,517	1,894	3,116	3,697
Town of Pendleton	100	A	1,175	1,253	1,516	1,815	3,589	4,411
		B	1,175	1,253	1,516	1,815	3,589	4,411
Town of Royalton	50	A	4,485	4,660	4,617	5,297	6,585	7,024
		B	2,242	2,330	2,308	2,648	3,292	3,512
Town of Wheatfield	38	A	1,884	2,212	3,077	4,720	8,008	9,349
		B	716	841	1,169	1,794	3,043	3,553
Total estimated population for Tonawanda Creek basin within Niagara County			8,883	10,485	11,574	14,334	21,729	24,119

* A = Total population for each community.

B = Estimated population within Tonawanda Creek basin, assuming population is evenly distributed throughout each community.

Existing Regulations

Present regulations for communities within the study area, with the exception of the town of Royalton in Niagara County do not have specific provisions to regulate building within the flood plain, or regulate the use of land with respect to flood risk, although development within known flooded areas is usually discouraged by local governments.

Under Section IV E of the Clarence Subdivision Regulations it is stated, "Flooding: Land subject to flooding shall not be platted for residential occupancy nor for such other uses as may increase the danger to life or property or aggravate the flood hazard."

The following is taken from the 1962 Zoning Ordinance for the town of Royalton:

"Section 37. Regulations Applying to the Flood Plain Use District
The following regulations shall apply to the X District:

(a) The provisions of Section 33 (Regulations applying to residential use districts) shall apply to the Flood Plain Use District except as may be provided otherwise in this section.

(b) (1) Buildings, structures or parts thereof erected, placed or otherwise located and used as places of habitation for humans shall be erected, placed or otherwise located so that the surface level of the first or principal floor of such buildings or structures shall be at least one foot above the surface level of the flood waters which inundated the area in March 1960.

(2) For the purposes of this section the surface level of the flood waters which inundated the area in March, 1960 is five hundred ninety-one (591) feet above sea level. Said elevation above sea level being as shown on topographic maps published by the United States Geological Survey. A copy of said topographic map being on file in the office of the Town Clerk."

The X District (Flood Plain Use District) is specifically described on page 8 of the Royalton Zoning Ordinance. It roughly includes the Riddle Road area between Bowen and Moyer Roads near mile 7.3 of Mud Creek and the Tonawanda Creek Road area in the vicinity of Riddle Road

near mile 21.0 of Tonawanda Creek. The requirement that first floor elevations of future development within the X District be one foot above the 1960 flood provides for flood elevations equivalent to the Intermediate Regional Flood or the 100-year flood.

Although zoning regulations have been in effect for the communities within this study area for a number of years, there are no provisions which regulate the use of land with respect to flood risk, except as stated above. However, the State of New York enabling statutes which permit city zoning, specify in Chapter 21, Article 2-A, Section 24, that "such regulations shall be designated to secure safety from fire, floods and other dangers, and to promote the public health and welfare...." The State of New York Town Law, Section 263, states "such regulations shall be made in accordance with comprehensive plan and designed to lessen congestion in the streets to secure safety from fire, floods, panic and other dangers to promote health and general welfare...." Also, Section 277 concerning planning boards and official maps, states that "land shown on such plats shall be of such a character that it can be used safely for building purposes without danger to health or peril from fire, flood or other menace."

The 1965 Legislature of New York State passed amendments adding Part IIIA, Use and Protection of Waters, to Article 5 of the Conservation Law. Although Part IIIA is not meant to regulate the flood plain, it does help prevent encroachment of streams, thereby helping to reduce future flood damages. Part IIIA states, in part, that no person or public corporation shall change, modify or disturb the course, channel or bed of any stream or shall erect, reconstruct or repair any dam or impoundment structure without a permit from the Water Resources Commission. The amendments became effective on 1 January 1966. The full text of the Act can be found in Chapter 955 Sections 429 a - g of the Laws of New York State - 1965

Flood Warning and Forecasting Services

Lower Tonawanda Creek and its tributaries are located within the effective range of the Weather Surveillance Radar operating continuously at the U.S. Weather Bureau, Buffalo Airport Station. This equipment provides for the early detection and plotting of heavy precipitation and makes possible immediate radio and television broadcasts of information concerning the predicted path and amount of rainfall from the storm.

At the present time not all communities within this study area have a definite plan for flood fighting and/or evacuation. Due to the relatively large area of the Tonawanda Creek basin, residents within Erie and Niagara Counties usually can be alerted to a possible flood situation by means of notification of flooding in areas upstream such as Batavia, Alexander and Attica.

Observations made through coordination of communities upstream of the study area along with observations made at existing and proposed gage locations within the study area would provide an indication of the timing and relative severity of a flooding situation.

Excellent observation points along Tonawanda Creek would be at the following existing gage locations: Attica, Batavia, Alabama, Rapids and Tonawanda near mile 2.6. It is suggested that reference points also be established at the Route 93 bridge near mile 34.3 and Campbell Boulevard near mile 8.71. Surveillance of the existing Erie County Department of Public Works staff gage located on Dann Road over Black Creek near mile 4.8 is also suggested.

These observations will provide flood warning to residents within the affected area. Although the anticipated flood may be of moderate proportions, forewarning permits public utilities, highway departments and property owners to set up warning and detours and to reduce flood damage as much as possible.

A survey of the communities within the study area showed that no formal flood warning program exists. However, surveillance of Tonawanda Creek and its tributaries is maintained by Highway Departments, local Police Departments and State and County law enforcement agencies.

The Stream and Its Valley

TONAWANDA CREEK - Tonawanda Creek is the largest tributary of the Niagara River, joining it about 13 miles from Lake Erie, and draining an area of about 648 square miles in Erie, Niagara, Orleans, Genesee and Wyoming Counties in western New York. It rises in the highlands of Wyoming County near North Java at an elevation of about 1,900 feet above mean sea level and flows generally northward between steep hills through Varysburg and Attica to Alexander, whence it meanders through flat land to Batavia at an elevation of about 890 feet; thence it turns abruptly westward flowing to Indian Falls, where it drops 160 feet over a length of approximately 1 mile, and then flows northerly to the Tonawanda Indian Reservation. From this point it forms the boundary between Niagara and Erie Counties, meandering generally westerly to confluence with the Niagara River at elevation 564. The lower 11.2 miles west of Pendleton form part of the New York State Barge Canal and have a navigable depth of 12 feet. The watershed is roughly L-shaped, with the broader and longer stem of the L extending east-southeast from the Niagara River to Batavia, New York and the smaller lobe extending therefrom at about a right angle to the south-southwest. The larger stem is about 40 miles long and 15 miles wide; the smaller, about 11 miles long and 7 miles wide.

Within this roughly L-shaped watershed Tonawanda Creek pursues a very meandering course, especially that section of the Creek upstream of the New York State Barge Canal. It achieves a total length of 109 miles in a basin roughly 60 miles long. Plate 1 shows the watershed and stream drainage system for the entire Tonawanda Creek basin.

RANSOM AND BLACK CREEKS - Ransom Creek rises about 1 1/2 miles east of Clarence and flows generally northwesterly about 16 1/2 miles to the canalized section of Tonawanda Creek, about 2 miles below Pendleton. Black Creek, a tributary, rises about 1 1/2 miles north of Clarence Center and flows north, west and southwest to join Ransom Creek 3.8 miles above Tonawanda Creek.

MUD CREEK - Mud Creek is the principal tributary of Tonawanda Creek on the northerly side of the basin. It rises near the Niagara-Orleans County border and flows generally west-southwesterly about 18 miles to Tonawanda Creek, 1 1/2 miles east of Pendleton.

Pertinent drainage areas of Tonawanda Creek and its tributaries are given in table 3.

NIAGARA RIVER TO PENDLETON - Tonawanda Creek from its mouth to the junction of the New York State Barge Canal, a distance of 11.2 miles, has a navigable depth of 12 feet, a navigable width of 75 feet and a total width of approximately 200 feet. The channel slopes in this reach are very flat.

Water levels in the canalized section of Tonawanda Creek depend chiefly on the stages of the Niagara River at Tonawanda, which are affected by wind and barometric conditions over the river and Lake Erie. During the navigation season of April to December approximately 1,100 cfs are diverted from the Niagara River eastly via Tonawanda Creek to the Barge Canal in addition to the flow from Tonawanda Creek.

This water is necessary for operation of locks and maintenance of pool levels east of Lockport. During the non-navigation season a gate is closed on the Barge Canal at Pendleton which allows all flows to go downstream toward the Niagara River. Because most flooding occurs during the winter months and early spring or the non-navigation season, flood waters are not affected by Barge Canal operation.

Since the removal of the dam in the city of Tonawanda in 1918, along with modernization of the Barge Canal, this reach has been relatively free of overbank flooding. During the 1960 flood, which was

TABLE 3

DRAINAGE AREAS WITHIN THE TONAWANDA CREEK BASIN

<u>Tonawanda Creek</u>	<u>Distance above Niagara River, miles</u>	<u>Drainage Area above Locality, square miles</u>
Source	109.3	0
Varysburg	97.1	48
Attica	87.1	81
Alexander	83.5	98
Little Tonawanda Cr. junction	72.8	151
Batavia, dam	67.7	174
Bushville (Route 5 bridge)	63.2	182
East Pembroke, dam	59.2	200
Indian Falls and Rapids	52.0	220
Hopkins Road at Alabama	41.5	230
Ledge Creek junction	33.0	317
Beaman Creek junction	23.3	356
Goodrich Road at Rapids	18.7	358
Mud Creek junction	13.0	414
New York State Barge Canal - Pendleton	11.2	
Ransom Creek junction	9.8	500
Bull Creek junction	4.8	537
Ellicott Creek junction	0.3	647
Niagara River junction	0.0	648
<u>Ransom Creek</u>		
Source	26.5	0
Tonawanda Creek junction	9.8	60
<u>Black Creek</u>		
Source	22.2	0
Ransom Creek junction	13.6	13
<u>Mud Creek</u>		
Source	31.0	0
Tonawanda Creek junction	13.0	51

the highest on the lower Tonawanda Creek in recent years, only minor damages were experienced by property owners. Most of the losses were to boathouses and docks along the creek.

PENDLETON TO TONAWANDA INDIAN RESERVATION - Tonawanda Creek from its junction with the New York State Barge Canal at Pendleton to the Tonawanda Indian Reservation is a straight-line distance of 12 miles. The channel distance for the same reach of Tonawanda Creek is 27 miles long and has very flat slopes. The surrounding area is a featureless plain into which the mainstream has cut a channel averaging 10 to 15 feet deep and 80 feet wide at the bottom. The channel is partly overgrown at many points by brush and trees as shown in figures 2 and 3 on page 26. Tributaries on both sides follow shallow, winding, overgrown channels nearly parallel to the main stream. Divides between streams are low and poorly defined. The area is agricultural with scattered summer and suburban residences along the main stream. Highways and buildings are above the general ground level and are less frequently affected by flood. During periods of high flow, the flood areas of Tonawanda Creek and some of its tributaries merge and water may flow across divides in either direction to equalize flood levels, making it difficult to measure discharges accurately. Peak flows are reduced by storage in flooded areas. Once flooding is started, it may be several weeks before small channels and poor local drainage can remove the water. The average area flooded annually in the reach from Pendleton to the Tonawanda Indian Reservation is about 10,000 acres. A large portion of the flood losses in the past resulted from difficulties and delays in planting. The late planting season restricts the type of crops which can be grown and interferes with crop rotation patterns. Table 4 shows that the amount of land in farms and crops harvested for towns in the vicinity of the study area has dropped while the population as shown in table 2 has increased. This indicates that principal flood losses will continue to shift from agricultural to residential, commercial, traffic delays and generally urban rather than rural damages.

TABLE 4
LAND IN FARMS AND CROPLAND HARVESTED - ERIE & NIAGARA COUNTIES

<u>Town</u>	<u>Total Farm Land in Acres</u>		<u>Total Cropland Harvested in Acres</u>	
	1950	<u>1954</u>	<u>1954</u>	1959
Amherst, Erie Co.	10,523	10,117	5,803	2,505
Clarence, Erie Co.	17,783	21,512	10,537	9,506
Newstead, Erie Co.	21,001	22,445	12,081	12,445
Tonawanda, Erie Co.	198	198	NA*	NA*
Lockport, Nia. Co.	23,387	22,925	11,620	9,792
Pendleton, Nia. Co.	11,317	11,793	5,663	4,080
Royalton, Nia. Co.	37,213	37,142	20,221	18,287

* NA Not Available

The channel width of Ransom Creek within this study area varies from approximately 60 feet wide near its mouth to 25 feet wide, with some locations having a width of only 10 feet as shown in figures 4 and 5 on page 27. The Black Creek channel is approximately 15 feet wide, although the channel is wider under most bridges. The channel of Mud Creek varies from approximately 40 feet wide near the lower end to as narrow as 15 feet wide near the upper end. In most cases the channel is wider under the bridges.

Flooding in the study area is relatively shallow even for infrequent floods so that development can readily be raised above the past and probable future flood levels. Elevations for safe development within the flood plain may be determined from profile plates 8 through 11.

Development in the Flood Plain

Plate 4 shows the extent of overbank flooding caused by Tonawanda Creek, both in Erie and Niagara Counties. It also is an index map of the three plates that show the flooded areas of Tonawanda, Black, lower Ransom and Mud Creeks. Plates 5, 6 and 7, prepared from the latest available U.S. Geological Survey quadrangle maps, show the flood plain for the reach covered by this study. Even though the scope of this report does not include Ellicott Creek, plate 5 shows a portion of the Ellicott Creek basin which would be affected during an occurrence of the Standard Project Flood in this area. A separate flood plain report for Ellicott Creek is presently being prepared and will be completed at the end of 1967.

Tonawanda Creek flows between the cities of Tonawanda and North Tonawanda which have a combined population of approximately 57,700. In this reach development along the banks of Tonawanda Creek is primarily confined to boat houses, both private and commercial, and



Figure 2. Example of partly overgrown channel as shown along Kelkenberg Road near mile 24.4.



Figure 3. A view of Tonawanda Creek just upstream of the Block Church Road bridge at mile 28.25 shows trees and brush in channel during a medium-high flow.



Figure 4. View of the Ransom Creek channel looking upstream from the New Road bridge at mile 3.0.



Figure 5. View of the Ransom Creek channel just downstream of the New Road bridge at mile 3.0. Note the large variance in channel width within the same area. In order for channel improvements to be effective they should be extended to the mouth.

a scattering of residential homes. Upstream from the city of Tonawanda to the confluence of the Barge Canal, much of the area is developed for recreational use such as parks, public boat marinas and golf courses as shown in figures 6 and 7 on page 30. Although the flood of 1904 caused a great deal of damage due to the former dam in Tonawanda, little damage has been suffered by individuals in this area since. An occurrence of the Standard Project Flood would cause wide spread flooding in this entire reach.

Development between the Tonawanda Creek - Barge Canal confluence and Rapids, New York is a combination of agricultural and residential. Damage from the 1960 flood was minor, but the Intermediate Regional Flood would cause a much larger amount of agricultural damage and an increase in residential loss. An occurrence of the Standard Project Flood in this reach would cause a large area to be flooded, affecting virtually all property from Tonawanda Creek south to the Ransom Creek - Black Creek basin.

The Tonawanda Creek reach between Rapids, New York and the Erie-Niagara and Genesee County line is devoted primarily to agricultural uses, with some new individual residential units being constructed throughout the area. The 1960 flood caused more widespread flooding and damage in this reach than in any other area along Tonawanda Creek within the study area. It is estimated that the Intermediate Regional Flood would cause flooding to be over one foot deeper and the Standard Project Flood over two feet deeper than the 1960 flood in this reach. Although these possible future floods would not cause flooding in great depth, they would cover a large area due to the relatively flat terrain.

The development along Ransom Creek, from its mouth to the confluence of Black Creek, is rapidly changing from an agricultural to a residential area. Most new construction is of individual homes rather than large sub-divisions. Some homes in the area are built up above the flood

plain as shown in figures 8 and 9 on page 31, while others are built level with the existing terrain. The 1960 flood caused much damage and many residential units were affected. The Intermediate Regional Flood and the Standard Project Flood would cause serious conditions in this reach, especially near the mouth of Ransom Creek where the Standard Project Flood would be approximately six feet higher than the 1960 flood. This is due to backwater from Tonawanda Creek.

Development within the Black Creek basin is still primarily agricultural, although an increase in individual residential units is evident. The largest concentration of flood damage is in the hamlet of Wolcottsburg near mile 8.8.

The majority of development in the Mud Creek basin is agricultural, with a scattering of farm homes, farm buildings and individual residential units throughout the area. The only exceptions are a large trailer court consisting of about 75 trailers, located on the left bank of Mud Creek, just upstream of Minnick Road near mile 2.5. An occurrence of the Standard Project Flood would affect only a few of the trailers as shown in figure 46 because most of them are located on higher ground. The other exception is the hamlet of Wolcottsville near mile 15.3, where a number of residential units and a few public and commercial buildings are located. Upstream of Ditch Road, just above the study area, the flood plain has been incorporated into the "Tonawanda Game Management Area," operated by the New York State Conservation Department. This is an excellent example of developing poorly drained and very frequently flooded areas into low damage recreational land use within the flood plain.

As future development occurs there are factors which can affect flood flows and stages in the flood plain area. Increased development and population result in increased and faster runoff from roofs, parking lots, roadside ditches and storm sewers. Road bridges and



Figure 6. This example of low damage development within the flood plain is located at the Ellicott Island Park near mile 3.3 along Tonawanda Creek.



Figure 7. Another type of low damage development within the flood plain is shown in this photograph of the Creekside Golf Course along Tonawanda Creek near mile 5.2.



Figure 8. Example of construction on natural ground, but wisely protected even against the Standard Project Flood by placing fill around home. Residence is located on Smith Road along Ransom Creek near mile 2.5.



Figure 9. Another example of good construction within the flood plain is shown by this home which was built entirely upon fill. Although the ground around this home would be flooded, the structure is high enough to be protected even against the Standard Project Flood. It is located on Rapids Road near mile 23.0 along Tonawanda Creek.

creekside fills can, unless regulated, cause restrictions under conditions of high flow. If there is no compensating improvement in the carrying capacity of the natural channel, an increase in development can result in increased discharges and flood elevations in the flood plain area. Since the flood plain is largely undeveloped, the purpose of this report is to identify the flood plain as shown on plates 5 through 7 and the frequency of flood stages so that future development can make the most effective use of the area without increasing present damages.

Bridges Across the Streams

Tonawanda Creek - Three railroad and fifteen highway bridges cross Tonawanda Creek in the reach covered by this study. Table 5 lists pertinent elevations for these structures and shows their relation to the crest of the March - April 1960 flood and the Standard Project Flood. Figures 10 and 11 on page 38 show the Main Street bridge in the city of Tonawanda and the Foot Road bridge near mile 37.7 which are considered to be typical of bridges over Tonawanda Creek.

Ransom Creek and Black Creek - Fifteen vehicular bridges cross lower Ransom and Black Creeks within the study area. Pertinent elevations for these structures and their relation to the crest of the March - April 1960 flood and the Standard Project Flood are listed in table 6. Plate 10 shows that the March - April 1960 flood waters were above the low steel of all fifteen bridges and over the floor elevation of most. The Standard Project Flood would put flood water over every bridge floor, with depths up to four and one-half feet. Although these bridges are overtopped by flood waters, they are generally larger in size than the adjacent channel cross sections. Figures 12 and 13 on page 39 show the extreme difference in bridge openings along Ransom Creek and Black Creek. Bridges within the study area are not considered to be overly constrictive because of the low elevations of the adjacent roads which allow large amounts of overbank flow.

Mud Creek - Thirteen vehicular bridges cross Mud Creek in the reach covered by this study. Table 7 gives pertinent elevations for these structures and shows their relation to the crest of the March - April 1960 flood and the Standard Project Flood. Plate 11 shows that an occurrence of the Standard Project Flood would cause flood waters to overtop almost all of the bridges over Mud Creek. Figure 14 on page 40 shows the new Rapids Road bridge near mile 3.8, completed in 1966, the waterway opening has a clear span of approximately 56 feet, some 8 feet wider than the old 3-span bridge. Figure 15 on page 40 shows the bridge at the old section of Lewiston Road over Mud Creek near mile 16.85 at the upper end of the study. The channel downstream of this bridge is badly overgrown with brush. Generally, the bridge openings are larger than the width of the channel.

Bridge tables 5 through 7 along with the profiles on plates 8 through 11 should be used as a guide for all future construction of new bridges or alterations to existing bridges along streams within the study area. This will assure against large increases in elevation or head loss caused by insufficient bridge waterway openings.

Obstructions to Flood Flow

Tonawanda Creek - The effect of obstructions to flood flow due to bridges are shown on plates 8 and 9. From Tonawanda to Pendleton, the canalized section of the creek, and from Pendleton to Rapids, the creek channel is in fairly good conditions, free from serious obstructions to flow. Upstream of Rapids, to Hopkins Road, the creek channel has many bends, an irregular section, and is obstructed by brush and trees growing on the banks and extending into the stream. The channel section is insufficient to prevent overflow at many places during spring and summer floods.

TABLE 5

BRIDGES ACROSS TONAWANDA CREEK

Mile Above Mouth	Identification	Stream Bed Elev.	Floor Elev.	Standard Project Flood Crest Elev.	Mar. - Apr. 1960 Flood Crest Elev.	Underclearance		
						Low Steel Elev.	Above 1960 Flood	Below 1960 Flood
0.10	NY Central Railroad	545.0	575.6	574.0	566.0	572.6	6.6	
0.15	River Rd. NY Hwy. 265	545.0	594.2	574.1	566.1	587.9	21.8	
0.25	Main Street	545.1	581.4	574.2	566.7	572.3	5.6	
0.40	Delaware Av. NY Hwy. 384	546.9	586.8	574.2	566.8	582.9	16.1	
0.55	NY Central Railroad	551.2	588.9	574.5	567.0	584.0	6.2	
0.65	Erie Railroad	550.9	588.2	574.6	567.2	584.6	7.4	
3.70	Robinson Street	548.1		577.3	570.7	587.1	16.4	
5.00	Niagara Falls Blvd. NY Hwy. 18 US Hwy. 62	546.8		578.0	571.9	586.4	14.5	
7.25	Bear Ridge Rd.	550.0		578.9	573.0	585.6	12.6	
8.70	Campbell Blvd. NY Hwy. 270	548.1		579.9	573.8	588.2	14.4	
11.50	New Road	557.9	581.7	581.7	575.9	578.3	2.4	
13.50	Transit Road NY Hwy 78 & 263	564.4	588.6	585.9	581.0	583.7	2.7	
18.70	Goodrich Road	569.2	593.8	591.0	588.3	590.5	2.2	
24.00	Rapids Road	569.7	597.1	595.4	593.0	593.8	0.8	
28.25	Block Church Road	575.0	599.7	599.5	597.3	596.4		0.9
34.35	Akron Rd. NY Hwy. 93	583.0	609.5	604.8	602.7	604.5	1.8	
37.70	Foot Road	590.9	613.6	609.7	607.7	611.2	3.5	
41.50	Hopkins Road	609.1	623.7	621.8	620.1	621.4	1.3	

TABLE 6

BRIDGES ACROSS LOWER RANSOM & BLACK CREEKS

Mile Above Mouth	Identification	Stream Bed Elev. feet	Floor Elev. feet	Standard Project Flood Crest Elev. feet	Mar. - Apr. 1960 Flood Crest Elev. feet	Underclearance	
						Low Steel Elev. feet	Below 1960 Flood Elev. feet
0.10	Tonawanda Cr. Rd.	555.6	575.9	580.5	574.5	572.6	1.9
1.80	Hopkins Road	564.3	579.7	581.4	580.2	576.3	3.9
2.60	Millersport Hwy. NY Hwy 263	566.9	581.0	581.8	580.5	576.7	3.8
3.00	New Road	568.4	580.2	582.0	580.5	577.1	3.4
3.85	Smith Road	569.4	580.0	582.8	581.0	577.2	3.8
4.80	Dann Road	573.4	582.8	585.5	584.0	580.3	3.7
5.00	Transit Rd. NY Hwy. 78	574.5	584.2	586.2	584.7	580.5	4.2
5.90	Westfallinger Road	575.9	584.5	587.0	585.8	582.0	3.8
6.00	Wolcott Road	576.9	586.0	587.2	586.1	583.8	2.3
6.40	Private Road	577.4	585.7	587.6	586.4	583.9	2.5
6.60	Kenfield Drive	577.6	587.3	587.8	586.6	585.4	1.2
7.70	Wolcott Road	581.0	587.6	588.9	587.6	586.4	1.2
7.75	Wolcott Road	580.8	587.8	588.9	587.7	585.6	2.1
7.80	Wolcott Road	580.7	588.3	589.0	587.8	585.9	1.9
8.80	Goodrich Road	581.4	590.6	590.9	590.2	587.8	2.4

Notes:

Mile 0.0 on Ransom Creek is at mile 9.8 on Tonawanda Creek.

Mile 3.8 is confluence of Ransom and Black Creeks.

TABLE 7
BRIDGES ACROSS MUD CREEK

Mile Above Mouth	Identification	Stream Bed Elev. feet	Floor Elev. feet	Standard Project Flood Crest Elev. feet	Mar. - Apr. 1960 Flood Crest Elev. feet	Underclearance		
						Low Steel Elev. feet	Above 1960 Flood feet	Below 1960 Flood feet
0.55	Transit Road NY Hwy. 78	565.9	584.6	585.9	580.7	580.4		0.3
2.40	Minnick Road	571.8	584.5	588.1	582.4	582.7	0.3	
3.80	Rapids Road	577.4	589.8	590.1	587.1	586.1		1.0
4.85	Wisterman Road	577.6	591.1	591.1	589.0	589.2	0.2	
7.30	Riddle Road	581.2	593.6	593.5	591.6	590.3		1.3
8.85	Simas Road	583.8	594.2	594.6	592.0	592.3	0.3	
9.85	Miller Road	585.6	596.2	596.5	594.5	593.6		0.9
11.40	Block Church Road	589.7	601.4	601.2	598.8	598.3		0.5
11.95	Akron Road NY Hwy. 93	590.9	602.8	602.5	600.4	599.2		1.2
15.25	Wolcottville Road	598.3	608.0	608.3	606.2	606.0*		0.2
15.50	Mann Road	600.4	607.6	608.4	606.5	605.6		0.9
16.45	Mann Road	604.5	608.4	609.8	607.7	606.9		0.8
16.85	Lewisston Road	605.0	611.0	611.0	609.0	609.0	0.0	0.0

Notes:

Mile 0.0 on Mud Creek is at mile 13.0 on Tonawanda Creek.

*Elevation of top of arch.

Obstruction to the channel of Tonawanda Creek due to bank slides is not uncommon. Figure 16 on page 41 shows the result of two slides which occurred a few days apart in May 1956. The slides took place on the left bank, about one half mile upstream from the New Road bridge crossing near mile 11.5. The slides completely destroyed approximately 500 feet of Tonawanda Creek Road. Before repairs were made to the road and the channel cleared the cross sectional area of the channel was reduced by 25% to 50% for half bankfull stages.

Figure 17 on page 41 shows an example of a man-made obstruction. The dam in the city of Tonawanda was damaged during the 1916 flood and removed during modernization of the Erie Barge Canal. However, it did aggravate the flood situation during its existence.

FLOOD SITUATION

Flood Records

Records of stages on Tonawanda Creek have been maintained since 1922 at Alabama and between 1955 and 1965 at Rapids. These records have been the basis for data presented in tables 8 through 10 and plates 2 and 3.

To supplement the records obtained at Alabama and Rapids, local residents were interviewed for information on past floods. Newspaper files were searched, as were historical documents and records. Valuable data were also obtained from reports of field investigations made after floods. These records and investigations have developed a knowledge of floods in the study area dating back to 1855.

Flood Stages and Discharges

Table 8 lists flood crests and peak discharges for the known floods exceeding bankfull stage of 11 feet at the U.S.G.S. gaging station on Tonawanda Creek at Hopkins Road, Alabama, New York. A stage of 11 feet

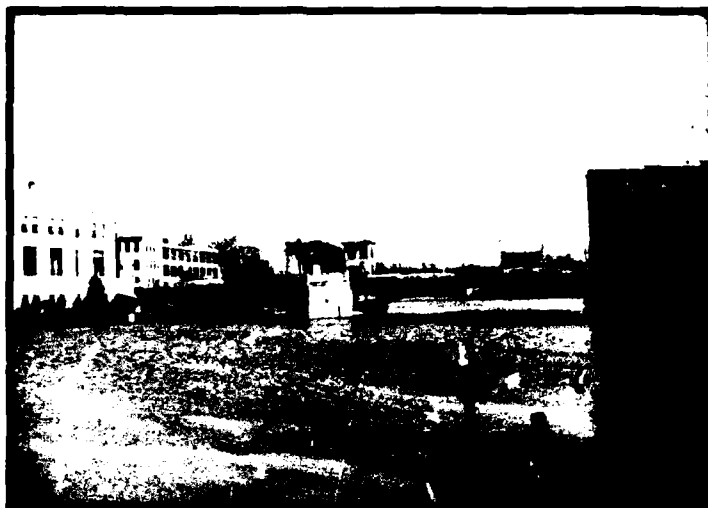


Figure 10. Looking upstream at the Main Street bridge over Tonawanda Creek at mile 0.25. Note the low steel of the right bank span is much lower than the left bank span.



Figure 11. View of the Foot Road bridge over Tonawanda Creek at mile 37.7. Bridge opening is large enough to pass flood discharges.

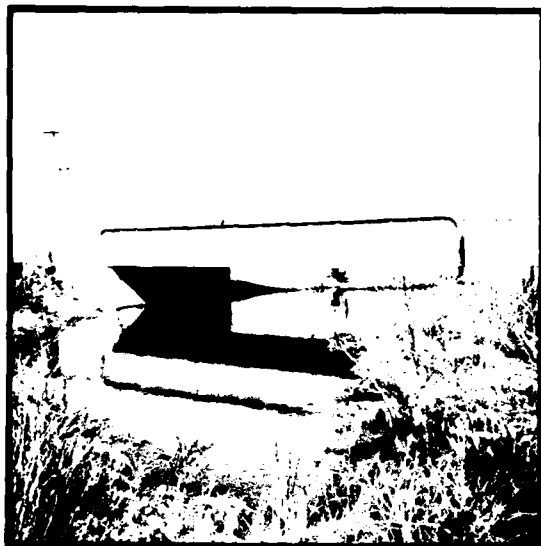


Figure 12. View of the New Road bridge over Ransom Creek at mile 3.0. Although the bridge opening is large, the channel narrows down to a width of only 10 to 15 feet a short distance downstream of the bridge.



Figure 13. This photograph shows the relatively small cross sectional area of the Kenfield Road culvert over Black Creek at mile 6.6. Future bridge construction should consider data provided in this report.

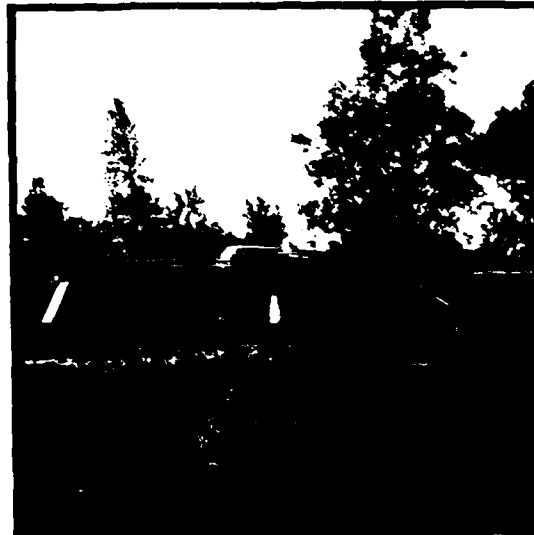


Figure 14. View of the new Rapids Road bridge over Mud Creek near mile 3.8. Even though it is larger than the old bridge, the channel is badly overgrown both upstream and downstream of the bridge, thereby hindering flood flows.

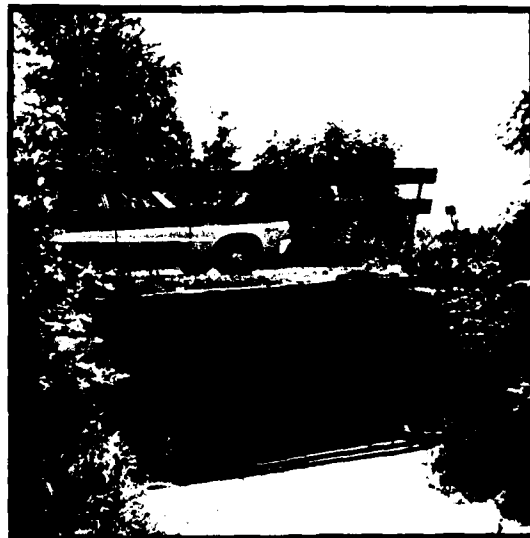


Figure 15. Looking downstream at the old Lewiston Road bridge over Mud Creek near mile 16.85. Looking downstream from this bridge, the channel is barely visible due to weeds and brush growing in the channel.



Figure 16. This bank slide which occurred in 1956, took place one-half mile upstream of New Road bridge along Tonawanda Creek. It exemplifies one of the many types of obstructions to flood flows.



Figure 17. Another type of obstruction to flood flows was the dam in the City of Tonawanda formerly located upstream of the Main Street bridge.

at Alabama will produce a discharge of 2,300 cubic feet per second, which is considered to be the maximum discharge Tonawanda Creek will contain without causing damage downstream of this location. From 1922 to 1955 the observed stages are based on New York State Department of Public Works staff gage readings. The annual maximum flood crest and flood peak for the 1922 to 1955 period was determined by producing a hydrograph based on the New York State staff gage readings. For floods since October 1955, the flood crests and flood peaks shown are those published by the U.S. Geological Survey. The stage for the March 1904 flood is based on a Barge Canal Office report, which was prepared shortly after the flood.

Table 9 lists the highest ten floods in order of magnitude at the Alabama site. It should be noted that duration of flood waters above bankfull is more critical than high instantaneous stages. A flood similar to 1960 will cause a tremendous amount of damage due to the fact it is above flood stage for a prolonged time, but a flood reaching a higher stage for a shorter duration above flood stage will cause less damage. This is because the degree of flooding on Tonawanda Creek as well as its tributaries is dependent upon the amount of overbank flow within the flood plain.

The crest stages and peak discharges for the known floods exceeding bankfull stage of 10 feet at the U.S.G.S. gaging station on Tonawanda Creek at Goodrich Road, Rapids, New York are listed in table 10. All data prior to August 1955 are based on high water marks, field investigations and historical documents. Crest stages and peak discharges between August 1955 and September 1965, the period of record at this site, are those published as annual maximums by the U.S. Geological Survey. These flows reflect only discharge at the recording gage site and do not include flow which bypasses the gage.

TABLE 8
TONAWANDA CREEK AT HOPKINS RD., ALABAMA, N.Y.
1904 - 1966

This table includes all known floods above bankfull stage of 11 feet at Hopkins Road over Tonawanda Creek near mile 41.5. Drainage area = 230 square miles. Zero of gage = 605.93 USC & CS Datum.

Between 1922 and 1955 observed peaks were obtained from New York Department of Public Works staff gage readings. The estimated annual peak stage and discharge for each year was obtained by reconstructing the largest flood each year based on the staff gage readings.

Between October 1955 and September 1965 flood stages and discharges were obtained from the U.S. Geological Survey crest gage and wire weight gage. In October 1965 an automatic recording gage was installed at the same location.

Based on N. Y. State Department of Public Works Data

<u>OBSERVED PEAKS</u>			<u>RECONSTRUCTED MAXIMUM ANNUAL PEAKS</u>			
<u>Flood</u>	<u>Gage Heights</u>		<u>Date of Crest</u>	<u>Gage Heights</u>		<u>Estimated Discharge cfs</u>
	<u>Stage</u> feet	<u>Elevation</u> feet		<u>Stage</u> feet	<u>Elevation</u> feet	
Mar. 1904	14.1	620.0				
Feb. 1922	12.9	618.8	Feb. 24, 1922	12.9	618.8	4,400
Mar. 1923	11.9	617.8	Mar. 4, 1923	12.5	618.4	3,760
Mar. 1923	11.7	617.6				
Jan. 1924	11.1	617.0	Jan. 12, 1924	11.8	617.7	2,930
Apr. 1924	11.1	617.0				
Feb. 1925	12.3	618.2	Feb. 24, 1925	12.5	618.4	3,830
Mar. 1926	12.4	618.3	Mar. 24, 1926	12.5	618.4	3,760
Nov. 1926	11.9	617.8				
Dec. 1927	12.8	618.7	Dec. 2, 1927	12.8	618.7	4,210
Dec. 1927	11.7	617.6				
Dec. 1927	11.3	617.2				
Jan. 1928	11.4	617.3				
Feb. 1928	11.9	617.8				
Mar. 1928	11.9	617.8				

TABLE 8 CONT'D

OBSERVED PEAKS			RECONSTRUCTED MAXIMUM ANNUAL PEAKS			
Flood	Gage Heights		Date of Crest	Gage Heights		Estimated Discharge cfs
	Stage feet	Elevation feet		Stage feet	Elevation feet	
Mar. 1928	11.1	617.0				
June 1928	12.7	618.6	June 22, 1928	13.0	618.9	4,550
Jan. 1929	13.1	619.0	Jan. 20, 1929	13.4	619.3	5,375
Apr. 1929	11.6	617.5				
Jan. 1930	12.5	618.4	Jan. 9, 1930	12.6	618.5	3,900
Feb. 1930	12.3	618.2				
Mar. 1931	11.7	617.6	Mar. 29, 1931	12.2	618.1	3,360
May 1931	11.6	617.5				
Feb. 1932	12.3	618.2	Feb. 12, 1932	12.3	618.2	3,520
Mar. 1932	12.0	617.9				
May 1932	12.1	618.0				
Mar. 1933	13.2	619.1	Mar. 16, 1933	14.3	620.2	7,945
Dec. 1933	11.0	616.9				
Jan. 1934	12.1	618.0				
Mar. 1934	12.7	618.6	Mar. 5, 1934	12.7	618.6	4,050
Jan. 1935	12.6	618.5				
Jan. 1935	11.8	617.7				
Feb. 1935	13.3	619.2				
Mar. 1935	13.8	619.7	Mar. 7, 1935	13.9	619.8	6,710
Feb. 1936	12.7	618.6				
Mar. 1936	13.4	619.3	Mar. 26, 1936	13.9	619.8	6,710
Mar. 1936	12.8	618.7				
Jan. 1937	11.3	617.2	Jan. 25, 1937	12.7	618.6	4,050
Apr. 1937	11.1	617.0				
Feb. 1938	13.0	618.9	Feb. 15, 1938	13.7	619.6	6,260
Mar. 1938	12.9	618.8				
Feb. 1939	14.0	619.9	Feb. 22, 1939	14.2	620.1	7,610
Mar. 1939	11.1	617.0				
Apr. 1940	14.5	620.4	Apr. 1, 1940	14.6	620.5	9,000
Mar. 1941	11.7	617.6				
Apr. 1941	14.0	619.9	Apr. 7, 1941	14.4	620.3	8,300
Mar. 1942	13.8	619.7	Mar. 18, 1942	13.9	619.8	6,860
Apr. 1942	12.0	617.9				
Nov. 1942	11.5	617.4				
Dec. 1942	13.0	618.9				

TABLE 8 CONT'D

OBSERVED PEAKS			RECONSTRUCTED MAXIMUM ANNUAL PEAKS			
<u>Flood</u>	<u>Gage Heights</u>		<u>Date of</u>	<u>Gage Heights</u>		<u>Estimated</u>
	<u>Stage</u>	<u>Elevation</u>	<u>Crest</u>	<u>Stage</u>	<u>Elevation</u>	<u>Discharge</u>
	<u>feet</u>	<u>feet</u>		<u>feet</u>	<u>feet</u>	<u>cfs</u>
Jan. 1943	11.4	617.3				
Jan. 1943	11.4	617.3				
Feb. 1943	12.2	618.1	Feb. 25, 1943	12.6	618.5	3,970
Mar. 1943	11.7	617.6				
Apr. 1943	11.1	617.0				
May 1943	11.9	617.8				
Mar. 1944	12.3	618.2	Mar. 17, 1944	12.6	618.5	3,900
Mar. 1944	11.7	617.6				
Apr. 1944	12.3	618.2				
Mar. 1945	12.5	618.4	Mar. 5, 1945	12.5	618.4	3,800
Jan. 1946	12.3	618.2				
Mar. 1946	12.7	618.6	Mar. 6, 1946	13.1	619.0	4,740
Jan. 1947	11.7	617.6				
Jan. 1947	11.2	617.1				
Mar. 1947	12.0	617.9				
Mar. 1947	11.4	617.3				
Apr. 1947	12.8	618.7	Apr. 7, 1947	12.8	618.7	4,210
June 1947	12.3	618.2				
Feb. 1948	12.6	618.5	Feb. 20, 1948	12.6	618.5	3,900
Feb. 1948	11.4	617.3				
Mar. 1948	11.6	617.5				
Mar. 1950	13.2	619.1	Mar. 28, 1950	13.5	619.4	5,625
Apr. 1950	12.1	618.0				
Dec. 1950	12.6	618.5				
Jan. 1951	12.7	618.6	Jan. 3, 1951	13.1	619.0	4,840
Feb. 1951	12.3	618.2				
Mar. 1951	11.7	617.6				
Apr. 1951	11.7	617.6				
Jan. 1952	12.6	618.5	Jan. 2, 1952	12.6	618.5	3,900
Feb. 1952	11.7	617.6				
Mar. 1952	12.4	618.3				
Dec. 1952	11.1	617.0				
Feb. 1954	12.9	618.8	Feb. 17, 1954	13.6	619.5	5,875
Feb. 1954	12.9	618.8				
Apr. 1954	11.8	617.7				
Mar. 1955	14.2	620.1	Mar. 2, 1955	14.2	620.1	7,510

TABLE 8 CONT'D

Based on U.S. Geological Survey Data

<u>Date of Crest</u>	<u>Gage Heights</u>		<u>Discharge</u> cfs
	<u>Stage</u> feet	<u>Elevation</u> feet	
Mar. 8, 1956	13.92	619.85	6,850
Apr. 4, 1956	12.15	618.08	3,340
Apr. 17, 1956	11.47	617.40	2,680
Apr. 30, 1956	11.64	617.57	2,810
May 13, 1956	11.18	617.11	2,450
Jan. 24, 1957	13.69	619.62	6,180
Feb. 27, 1957	11.52	617.45	2,720
Mar. 13, 1957	10.94	616.87	2,280
Apr. 7, 1957	12.14	618.07	3,330
May 21, 1957	12.80	618.73	4,260
Apr. 7, 1958	12.33	618.26	3,560
Jan. 23, 1959	15.95	621.88	6,550
Feb. 17, 1959	13.24	619.17	5,080
Mar. 22, 1959	13.10	619.03	4,800
Apr. 3, 1959	14.05	619.98	7,250
Dec. 14, 1959	11.89	617.82	3,050
Jan. 15, 1960	11.37	617.30	2,600
Feb. 12, 1960	12.89	618.82	4,400
Mar. 31, 1960	14.28	620.21	7,980
Feb. 2, 1961	12.33	618.26	3,560
Apr. 26, 1961	12.88	618.81	4,390
Mar. 14, 1962	13.25	619.18	3,000
Mar. 19, 1963	13.18	619.11	4,960
Mar. 27, 1963	12.18	618.11	3,380
Mar. 6, 1964	13.33	619.26	5,280
Mar. 16, 1964	12.50	618.43	3,800
Feb. 10, 1965	13.86	619.79	5,200
Apr. 8, 1965	11.80	617.73	2,960
Feb. 13, 1966	12.45	618.38	3,730
Mar. 6, 1966	10.98	616.91	2,310

TABLE 9
HIGHEST TEN KNOWN FLOODS IN ORDER OF MAGNITUDE
TONAWANDA CREEK AT HOPKINS RD., ALABAMA, N.Y.

<u>Order</u> <u>No.</u>	<u>Date of Crest</u>	<u>Gage Height</u>		<u>Peak</u> <u>Discharge</u> cfs	<u>Approximate</u> <u>Days above</u> <u>Flood Stage</u>
		<u>Stage</u> feet	<u>Elevation</u> feet		
1	January 23, 1959	16.0	621.9	6550 (1) (2)	3
2	April 1, 1940	14.6	620.5	9000 (1)	6
3	April 7, 1941	14.4	620.3	8300 (1)	2
4	March 31, 1960	14.3	620.2	7980	6
5	March 16, 1933	14.3	620.2	7945 (1)	2
6	March 2, 1955	14.2	620.1	7610 (1)	1
7	February 22, 1939	14.2	620.1	7610 (1)	3
8	March 1904	14.1	620.0		N.A.
9	April 3, 1959	14.1	620.0	7250	2
10	March 8, 1956	13.9	619.8	5860	2

(1) Estimated by Corps of Engineers

(2) Stage affected by Ice Jam

N.A. Not Available

TABLE 10
TONAWANDA CREEK AT RAPIDS, N.Y.

1865 - 1965

This table includes all known floods above bankfull stage of 10 feet for Tonawanda Creek at Rapids, N.Y. near mile 18.7. Drainage area = 358 square miles. Zero of gage = 571.28 USC & GS Datum.

<u>Date of Crest</u>	<u>Gage Heights</u>		
	<u>Stage</u> feet	<u>Elevation</u> feet	<u>Discharge</u> cfs
	<u>Based on Various Sources</u>		
March 1865	18.9	590.2	
March 1904	17.5	588.8	
March 1936	16.3	587.6	
March 1945	14.7	586.0	
March 1950	15.4	586.7	
February 1954	14.7	586.0	

Between August 1955 and September 1965 all flood stages and discharges were obtained from the U. S. Geological Survey automatic recording gage at Rapids and does not include flow bypassing the gage.

	<u>Based on U.S. Geological Survey Data</u>		
March 10, 1956	15.20	586.48	5090
April 6, 1956	10.54	581.82	3230
January 25, 1957	15.46	586.74	5210
March 1, 1957	10.91	582.19	3350
May 22, 1957	11.25	582.53	3480
1958*			
January 26, 1959	11.97	583.25	3760
April 4, 1959	13.70	584.98	4450
February 14, 1960	11.60	582.88	3600
April 1, 1960	16.96	588.24	6280
February 2, 1961	10.01	581.29	3000
April 27, 1961	11.83	583.11	3700
March 15, 1962	11.58	582.86	3100
March 20, 1963	15.32	586.60	4300
March 29, 1963	11.00	582.28	3380
March 7, 1964	12.95	584.23	4160
March 17, 1964	10.76	582.04	3290
February 12, 1965	13.18	584.46	4270

*None above 10 feet

Flood Occurrences

Plate 2 shows known crest stages and years of occurrence of known floods since 1865 which have exceeded the bankfull stage of 10 feet on Tonawanda Creek at Rapids, New York. Also shown on plate 2 are known stages and years of occurrence of known floods since 1904 which have exceeded the bankfull stage of 11 feet on Tonawanda Creek at Hopkins Road, Alabama, New York

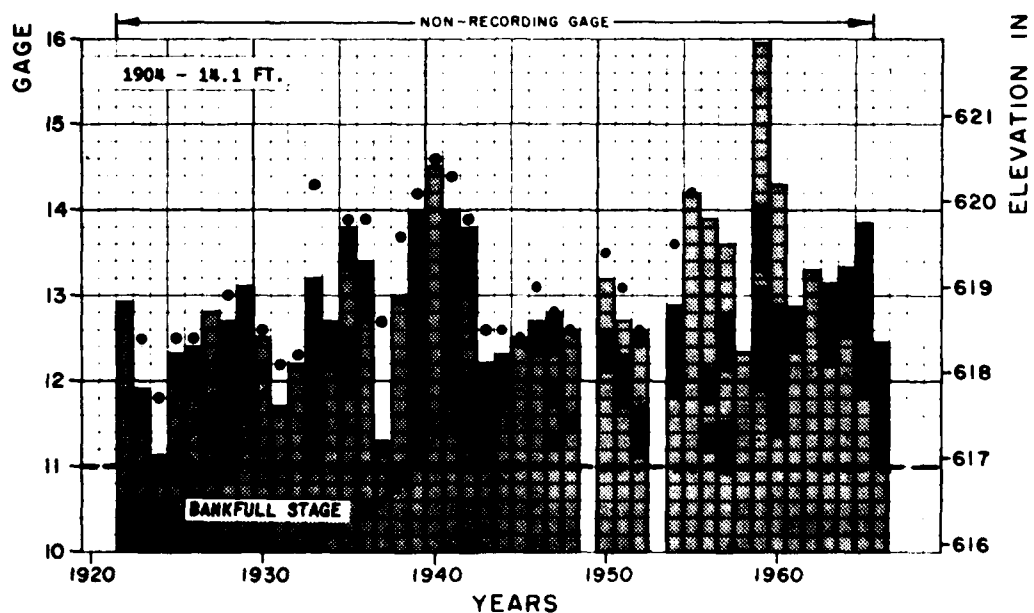
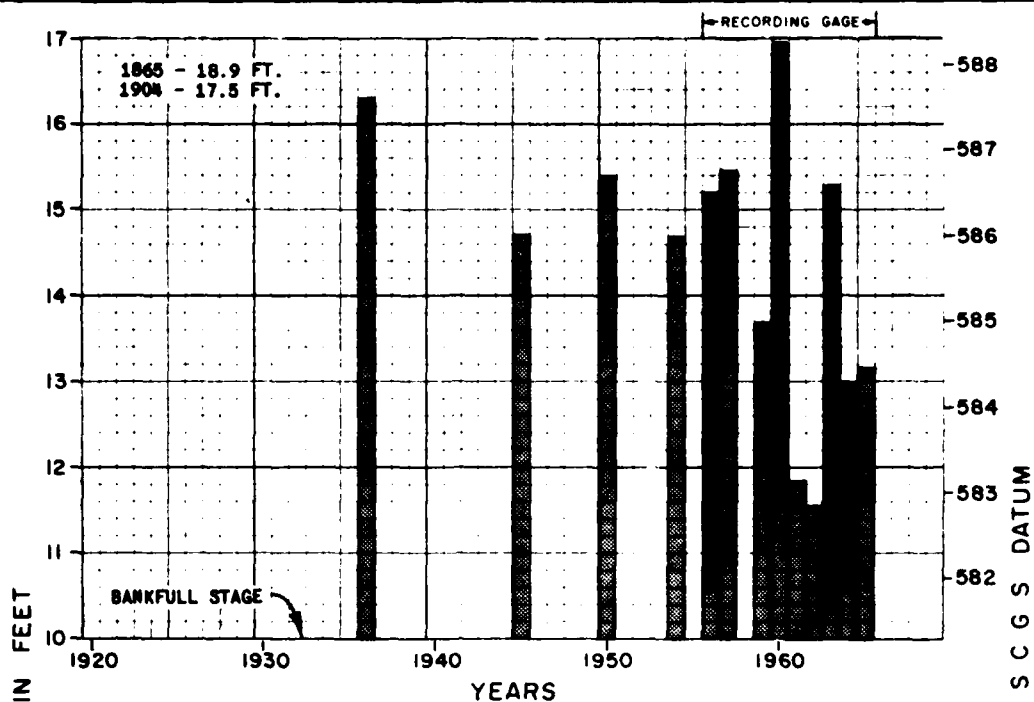
Duration and Rate of Rise

Plate 3 shows the stage hydrographs of the March - April 1960 flood at the U.S.G.S. gaging stations on Tonawanda Creek located at Rapids and Alabama. The 1960 flood was caused primarily by high temperatures, which rapidly melted the heavy snow cover. Rainfall on 4 April caused a second peak, which once again caused Tonawanda Creek to go above bankfull stage at Alabama and extended the duration of flooding at Rapids.

During the 1960 flood the creek rose to its crest at Rapids in 74 hours at an average rate of 0.2 foot per hour with a maximum rate of 1 foot in 4 hours, and remained above bankfull stage 7 1/2 days. The 1960 flood reached its crest at Alabama in 84 hours at an average rate of 0.1 foot per hour with a maximum rate of 1 foot in 3 hours, and remained above bankfull stage 6 days with the exception of a 22 hour period on 2 and 3 April.

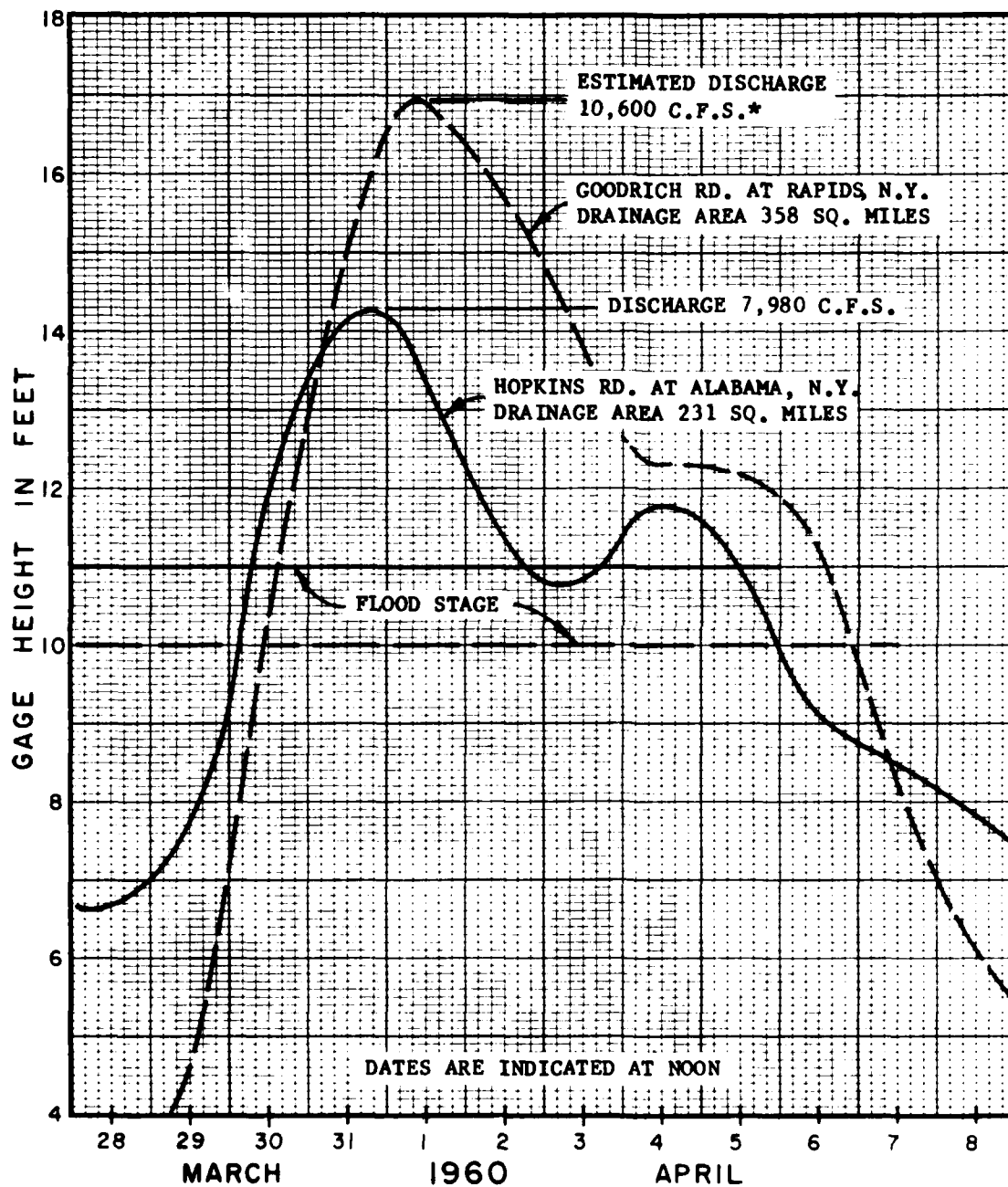
Velocities

During the March - April 1960 flood, velocities in the channel of Tonawanda Creek at Rapids were measured at 5.3 feet per second. At Hopkins Road, Alabama the channel velocities exceeded 9 feet per second. Velocities of 2 feet per second were measured over Goodrich Road during the March - April 1960 flood. During larger floods, such as the Intermediate Regional and the Standard Project velocities would be higher.



Variation in shading on the bar graph indicates more than one flood during the year. For example, in 1950 there were 3 floods; observed gage heights were 12.1, 12.6 and 13.2. The estimated annual peak is 13.5, denoted as ●.

FLOODS ABOVE
BANKFULL STAGE



— RAPIDS AUTOMATIC RECORDING GAGE
AT STREAM MILE 18.7
ZERO OF GAGE 571.28 U.S.C. & G.S.
FLOOD STAGE 10.0 FT. OR ELEV. 581.3

— ALABAMA WIRE WEIGHT GAGE
AT STREAM MILE 41.5
ZERO OF GAGE 605.93 U.S.C. & G.S.
FLOOD STAGE 11.0 FT. OR ELEV. 616.9

*INCLUDES TONAWANDA CREEK OVERFLOW
DOWN BLACK CREEK

TONAWANDA CREEK
ERIE & NIAGARA COUNTIES, N.Y.

STAGE HYDROGRAPHS AT RAPIDS AND ALABAMA

U.S. ARMY ENGINEER DISTRICT, BUFFALO

Flooded Areas, Flood Profiles, and Cross Sections

Plates 5 through 7 show the approximate areas along Tonawanda, lower Ransom, Black and Mud Creeks that would be inundated by the Intermediate Regional Flood and the Standard Project Flood. Plate 4 shows the entire area affected by Tonawanda Creek and serves as an index map for plates 5 through 7. The actual limits of these overflow areas on the ground may vary some from those shown on the map because the 10-foot contour interval and scale of the map do not permit precise plotting of the flooded area boundaries.

Plates 8 through 11 show the high water profiles for March - April 1960 flood. Also shown are the profiles for the Intermediate Regional Flood and the Standard Project Flood discussed in the "FUTURE FLOODS" section of this report.

Plates 12 through 14 show 9 valley sections that are indicative of the terrain within the study area investigated. The locations of the sections are shown on plates 5 through 7. The elevation and extent of overflow of the March - April 1960 flood, the Intermediate Regional Flood, and the Standard Project Flood are indicated on these sections. Approximate normal water surface elevations are also indicated.

By using the flooded area maps, flood profiles and cross-sections, contained in this report as a guide, limited urban development, dependent upon the frequency of flooding, can be allowed in the flood plain. This is possible because of the relatively shallow flooding in this area.

Continued recreational use within the flood plain for wildlife areas, game preserves, marinas and golf courses should be encouraged. Similar land use as well as other low damage construction should be stressed during future development in areas which are susceptible to frequent flooding.

FLOOD DESCRIPTIONS

Descriptions of known large floods that have occurred on Tonawanda, lower Ransom, Black and Mud Creeks within Erie and Niagara Counties, New York are based upon field investigations, newspaper accounts and historical records.

The following are excerpts from an investigation of flood conditions following the 1904 flood on the lower Tonawanda Creek Watershed by Glenn D. Holmes of the Barge Canal Office dated 17 September 1904.

"The flood of 1865, was the most severe of any that has occurred. At Rapids the flood reached an elevation of about 590 or 16 feet above the normal water level. March 1865 was a period of general high water throughout Western New York. Long continued cold weather and heavy snowfall were followed by a sudden thaw, accompanied by rain."

"Severe floods occurred also in the Spring of 1889, 1893, 1894, 1896 and 1902. The summer flood of July 1902, was perhaps the most disastrous to the agricultural interests of any, occurring as it did just before the harvest season. Between Rapids and the Feeder Dam (0.3 mile upstream of Hopkins Road) this flood reached nearly the same height as the high spring floods; a strong current of water passed over the flats one to two feet deep through Wolcottsburg to Black Creek. High water occurred also in the summer of 1903 and did much damage to crops, especially to grain, which in many localities could not be harvested at all."

March 1904

"The spring flood of 1904 seems to have been nearly as severe as the one of 1865. High water continued for three to four days making all roads in the flooded district impassable. The lower floors of many dwellings, especially in the vicinity of Wolcottsville and Wolcottsburg were flooded. The flats to the east of Wolcottsville were covered to

a depth of 4 to 6 feet; south of Dysinger, 3 to 4 feet; vicinity of Wolcottsburg, 2 feet. The road running northwest from Swormville to Pendleton was 2 1/2 to 3 feet under water. Flood water reached nearly the same height here in July 1902. North of Getzville the water averaged 1 foot deep over the flats. A large part of the city of Tonawanda was under water, and it is said there was hardly a cellar in the city which was not flooded."

Mr. Holmes stated that the March 1904 flood inundated an estimated 50,000 acres and produced a discharge of approximately 15,600 cfs in the city of Tonawanda. He estimated the removal of the dam at Tonawanda with channel improvement to the canalized section would lower the 1904 flood height 8.4 feet at the Tonawanda dam to 4.1 feet at Pendleton. He also stated about 25,000 acres of land in the lower watershed would be permanently relieved from danger of overflow from flood waters of the Tonawanda Creek.

The next major flood in the lower Tonawanda Creek basin occurred in 1916. Figures 18 and 19 on page 54 are views of the flood situation in 1916.

March - April 1940

Rain and high temperatures turned placid streams into raging rivers in many sections of Western New York. Flooded lowlands in the vicinity of Tonawanda Creek and its tributaries caused State Police to warn motorists against using inundated highways.

Tonawanda Creek flood waters backed up Beeman Creek, crossed Salt Road (Route 268) and flowed west into the Black Creek area. The reach from Salt Road to Ransom Creek was inundated with flood waters and extended almost a mile in width. The flood occurred after all water from the local area had passed off. Local water causes little damage in the area. In 1940 the residents were notified in advance of the danger of having high water. The farmers raised their cattle and

placed their chickens and small animals in hay barns. All tools and equipment were placed in the sheds and lumber fastened down. Still with all this preparation many suffered losses in their basements, barns and fields. The flood water stayed over the land for almost a week. During this high water period, six families from the Ransom - Black Creeks area had to move from their homes. The flood damage in the Beeman, Black and Ransom Creeks area was estimated at \$10,700. Figures 20 and 21 on page 55 show typical flooding in the area.

No serious damage was reported in the area between Rapids and the Barge Canal. A few residents had their basements flooded and lost shrubs, sheds and fire places which were located on the creek banks. Based on the stage-frequency curve at Hopkins Road, this flood has a recurrence interval of approximately once in 25 years.

March 1942

After Tonawanda Creek reached an all time known peak of 14.5 feet at Batavia, its flood waters rushed down to the lower Tonawanda basin, inundating large areas of northern Erie County in Clarence, Newstead and Amherst Townships. Tonawanda Creek overflowed in a number of locations and spread a large brown lake over lowlands along its banks. The Erie County Highway Superintendent closed 14 county roads, sections of which were covered by 6 to 18 inches of water. Many homes were surrounded and basements experienced flooding. Residents of Wolcottsburg and Swormville had been warned by State Police of the approaching flood, thereby giving farmers an opportunity to move poultry and perishable property out of danger. It is estimated that this flood has a recurrence interval of once in 5 years based on the stage-frequency curve at Hopkins Road.

February 1954

The storm of 16 and 17 February exceeded all previous records for February in the Buffalo area, when 2.47 inches of rainfall was



Figure 18. View of damaged canal boats during the 1916 flood. Photograph also shows former dam located at mile 0.3 in the City of Tonawanda.



Figure 19. The wide extent of flooding is shown in this photograph taken at the intersection of Goodrich and Wolcott Roads during the March 1916 flood. This location is approximately at mile 8.8 along Black Creek.



Figure 20. Looking north along Millersport Highway toward Ransom Creek at mile 2.6 during the April 1940 flood.



Figure 21. Extensive flooding is shown in photograph looking north along New Road toward Smith Road. Photograph was taken at mile 3.0 along Ransom Creek during the April 1940 flood.

recorded from 2:47 A.M. of the 16th to 1:45 P.M. of the 17th. Of this amount, 2.21 inches fell in the first 24 hours, bettering the old February 24-hour record of 2.19 inches set 6 and 7 February, 1942. It was found, upon investigation, that much of the widespread inundation reported in newspapers and by volunteer observers was due to the inability of storm sewers to carry off the surface water rather than the overbank flooding of natural waterways. However, six basements in the town of Amherst were flooded and many roads in the towns of Amherst, Clarence and Newstead were closed from 36 to 60 hours because of overbank flooding. It was reported Foot and Mann Roads were closed due to an estimated depth of six feet of water at this junction. A few residents in this area required boats to obtain access to their homes. Figure 22 on page 58 shows typical road flooding during the high water period. Based on the Hopkins Road stage-frequency curve this flood has an approximate recurrence interval of less than 5 years.

March 1956

During the flood many homes and buildings were surrounded by water with a few affected on the first floor. Rescue boats manned by State Police and 100 volunteer firemen from Clarence and Newstead Fire Companies patrolled along Tonawanda Creek. Two families in the Fletcher Road area of Newstead had to be evacuated while other families, even though isolated, refused evacuation. In the Mud Creek area a family was evacuated from their flooded Simms Road home in the town of Royalton, twenty-five volunteers stood by in case they were needed at neighboring homes. It was concluded that there probably would have been no flooding along Black Creek except for the overflow from Tonawanda Creek. Peak discharges at the two gage sites were determined to be 6,860 cfs at Hopkins Road and 5,090 cfs at Rapids. The flow at Rapids including flow over Goodrich Road and Black Creek was estimated to be 6,400 cfs. This indicates a quantity of flood water is stored in the low, flat area upstream of Goodrich Road. The flood was slightly above a 5-year frequency based

on the stage-frequency curve at Hopkins Road. Estimated loss attained during the flood was set at \$121,000. Figure 23 on page 58 shows flood waters against the low steel of the Block Church Road bridge over Tonawanda Creek during the March 1956 flood. Figure 24 on page 59 shows the widespread flooding in the Route 93 - Wolcottsville area, while figure 25 shows the extent of Mud Creek overflow in the Simms Road area during the March 1956 flood.

January 1957

This flood was very similar to the March 1956 flood. The depth of flooding at Rapids was only a few inches deeper and once again flooded thousands of acres. Many roads had to be closed to traffic because of the flood waters. Highway crews rescued motorists from five stalled autos in the vicinity of Bratt's Bridge (Route 93 over Tonawanda Creek). One rescue team member reported, "The water is the highest I have ever seen it at Bratt's Bridge and I've lived right by the creek all my life." Several homes in the sections adjoining Fletcher Road and Route 93 were isolated. Water over the roads ranged from two to four feet deep. An estimated 15 persons were taken to safety in the Newstead area by State Highway Department trucks. The Erie County Sheriff aboard a Bell helicopter rescued a couple from their inundated home on Fletcher Road. High flood waters also inundated Bartel Ditch, Hellert and portions of Riddle Road in the town of Royalton, creating problems to farmers and their live stock. After the flood waters started to recede, the low temperatures created hazardous driving conditions when the shallow flood waters froze into large sheets of ice. For the first time, an attempt was made to determine the amount of flow which bypasses the Rapids recording gage. On 25 January the U.S. Army Corps of Engineers made a discharge measurement of Black Creek at Goodrich Road and also measured the water flowing over Goodrich Road. The discharge measurements showed that at least 1,020 cfs was flowing over this bypass route, at the same time the Rapids gage was peaking at 15.46 feet with a discharge of 5,210 cfs.



Figure 22. Photograph shows overbank flooding during the February 1954 flood near the confluence of Beeman and Tonawanda Creeks.



Figure 23. Looking downstream at the Block Church Road bridge over Tonawanda Creek at mile 28.25 during the March 1956 flood.



Figure 24. Looking west on Route 93 from intersection with Wolcottsville Road. Photograph was taken during the March 1956 flood near mile 34.3 along Tonawanda Creek.



Figure 25. Looking northwest from Simms Road near the Mud Creek bridge at mile 8.9. Photograph shows about 6" of water surrounding the trailers during the March 1956 flood.

The flood peak was estimated to have passed Hopkins Road during the early morning hours of January 24th with a flow of 6,180 cfs and a stage of 13.69. This stage is equal to a recurrence interval at Hopkins Road of less than once in 5 years.

March - April 1960

The worst flood in recent years and one of the worst of all time occurred on Tonawanda Creek and its tributaries during late March and early April. Residents who have lived all their lives in the affected area and have been through many floods described this flood as the worst since the big flood of 1916.

High temperatures of 67° on 29 March and 69° on 30 March were recorded at the Buffalo Weather Bureau, causing a large amount of runoff from the 8 inches of snow covering the area. Many roads, both in Erie and Niagara County were inundated by flood waters of Tonawanda Creek and its tributaries. Many residents were unable to reach or leave their homes. Swormville volunteer firemen evacuated several families along Lapp Road and Tonawanda Creek Road. Civil Defense officials in Niagara County estimated that 35 families were cut off by high water during the flood. Newspaper accounts of the flood stated that when the two-mile ice jam along Tonawanda Creek Road in the town of Pendleton broke, it carried with it between 40 to 60 small boat docks and boat houses. The creek crested on the morning of 1 April at 16.96 feet, an all time high at the Rapids gage installation. Due to the record creek stages at many locations along Tonawanda Creek and its tributaries, many areas never before affected by floods were inundated. Also affected were new homes built in the flood plain. Unlike the older farm houses and barns which were built on mounds in an attempt to stay above floods, many of these homes were constructed level with surrounding terrain. Consequently they were inundated. Many of these residential homes suffered large monetary losses because of basement flooding, loss of wages and other

reasons directly attributable to the flood. Throughout the flood period rescue teams from the Erie County Sheriff's Department amphibious unit, Niagara County C.D. amphibious unit, police, highway crews and volunteer firemen observed the flooding and gave assistance when needed.

A Corps of Engineers post-flood report for lower Tonawanda Creek and its tributaries in Erie and Niagara Counties showed 450 residential units, 48 commercial units, and 250 agricultural units affected. The total area inundated by lower Tonawanda Creek, lower Ransom Creek, Black Creek and Mud Creek was estimated to be 19,700 acres, of which 15,300 acres was farm land. The stage-frequency curve at Hopkins Road indicates this flood to have a 10-year recurrence interval.

Figures 26 through 29 on pages 62 and 63 show typical conditions during the flood along Tonawanda Creek. Figures 30 and 35 on pages 64 through 66 are indicative of the inundated areas along Black and Ransom Creeks during the 1960 flood.

This concludes the "General Conditions and Past Floods" section of this report. But what can be done to prevent or reduce future flood damages? The U. S. Army Corps of Engineers has prepared and is distributing to State, county and local governments copies of pamphlets entitled "Guidelines for Reducing Flood Damages" and "Introduction to Flood Proofing." The combination of data presented in this Flood Plain Report and the pamphlets will provide general guidelines for flood damage reduction to future development within the Tonawanda Creek flood plain. Figure 36 on page 67 lists the corrective and preventative measures described in the above mentioned pamphlets. The U. S. Army Corps of Engineers will distribute to State, county and local governments other helpful pamphlets as well as additions to existing guidelines as they are developed.

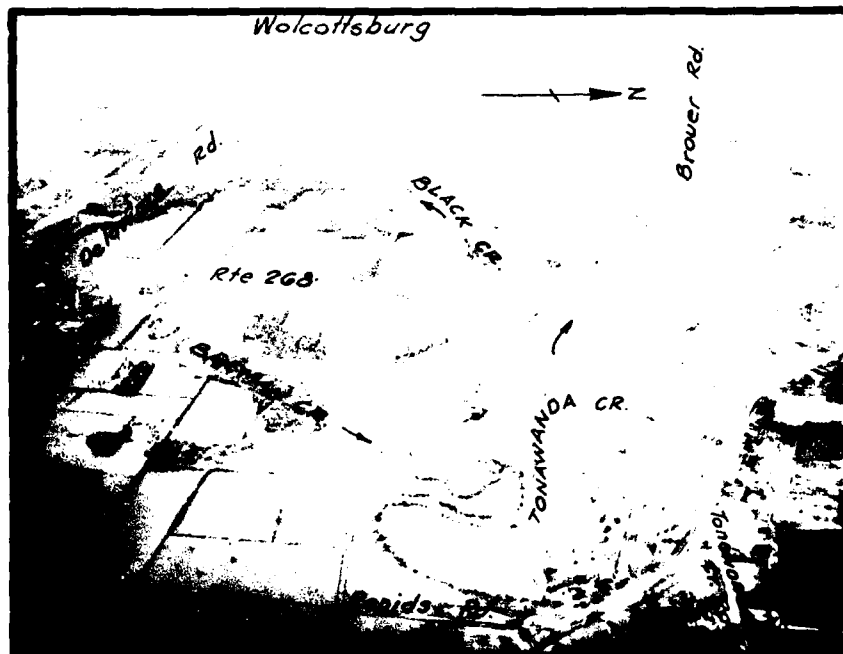


Figure 26. Aerial view of flooding during the 1960 flood in the vicinity of Tonawanda Creek, Black Creek and Beeman Creek.



Figure 27. The extent of Tonawanda Creek overflow is shown by this photograph taken during the 1960 flood in the vicinity of Burdick Road near mile 27.



Figure 28. Residence at Goodrich and Brauer Roads inundated by 1960 flood water from Tonawanda and Black Creeks.



Figure 29. Photograph shows intersection of Tonawanda Creek Road (Route 268) and Brauer Road. This location near mile 21.3 is one of the initial points where Tonawanda Creek flood waters break over the bank.



Figure 30. Aerial view of flooding along Ransom Creek in the vicinity of Millersport Highway during the 1960 flood.

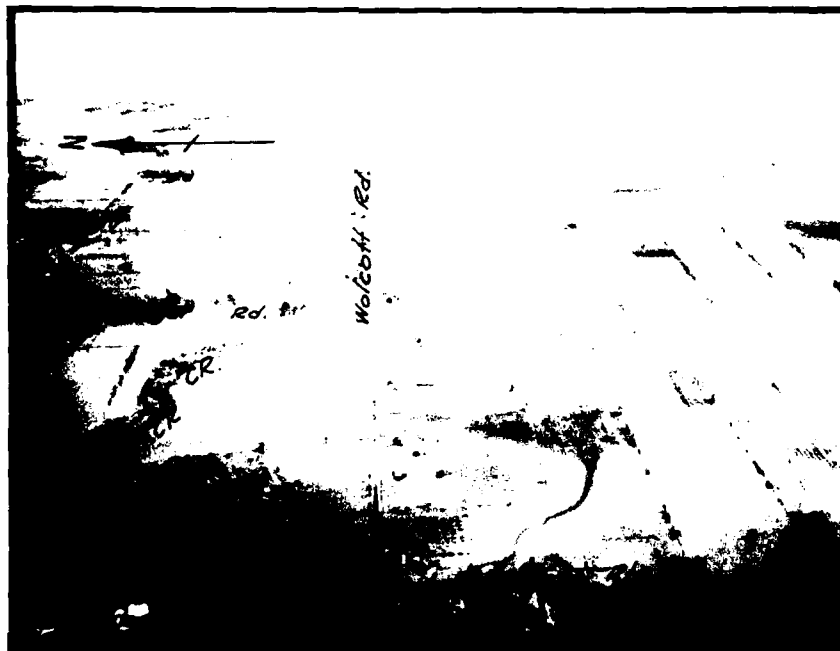


Figure 31. Wide spread flooding is shown by this aerial photograph taken in the vicinity of Transit Road and Wolcott Road along Black Creek near mile 5, during the 1960 flood.

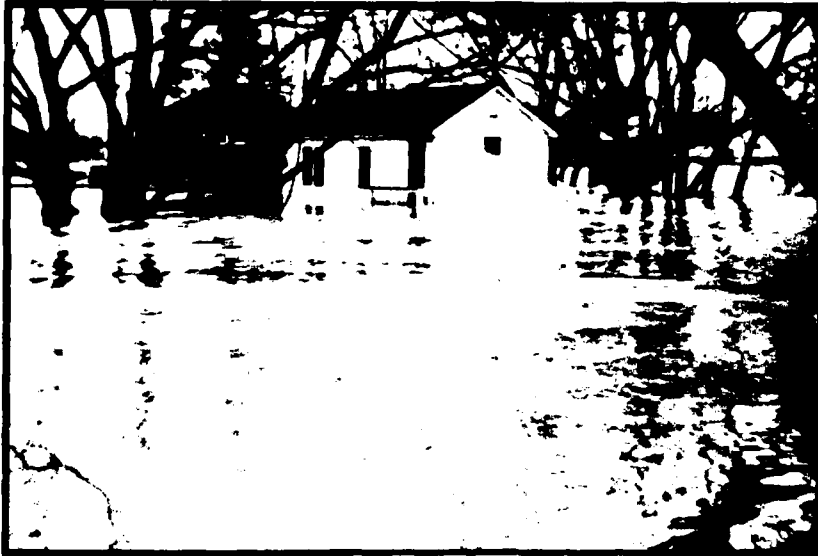


Figure 32. Photograph shows flood waters around a cottage located near mouth of Ransom Creek. The water surface during the 1960 flood was over nine feet above normal in this area.

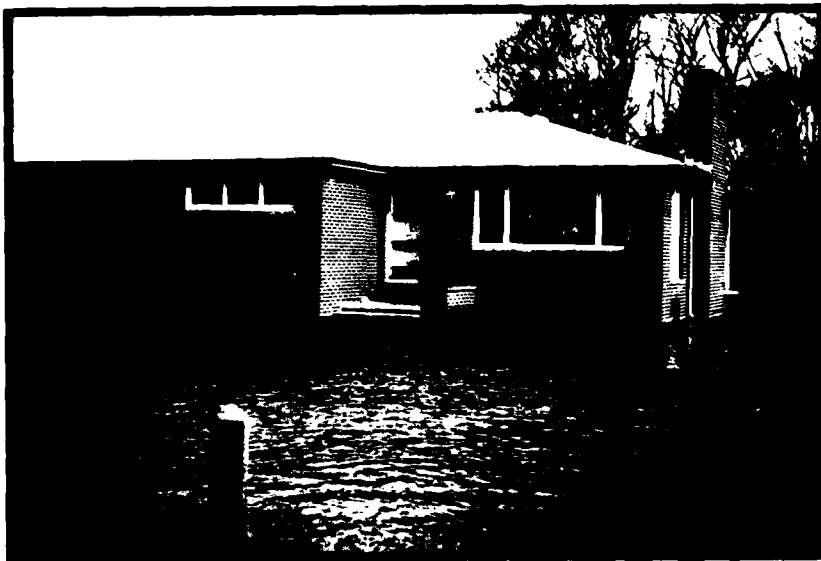


Figure 33. Photograph of residence on Hopkins Road near mile 1.8 along Ransom Creek during the 1960 flood. Construction of this home upon a little fill would have prevented damage from the 1960 flood.



Figure 34. Inundated residence on New Road near mile 3.0 along Ransom Creek during the 1960 flood.

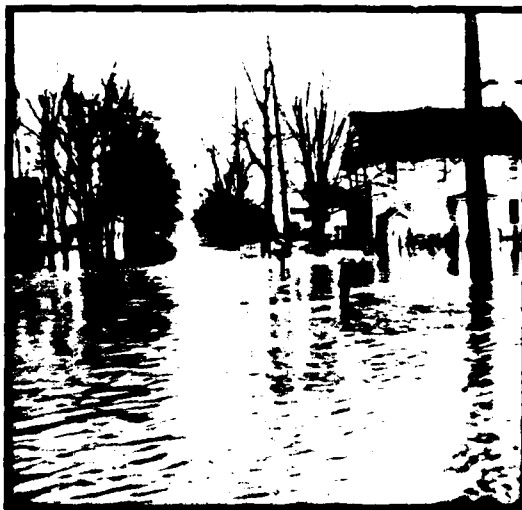


Figure 35. Looking north along Goodrich Road at Wolcott Road near mile 8.8 along Black Creek during the 1960 flood.

FLOOD DAMAGE PREVENTION

CORRECTIVE MEASURES

FLOOD CONTROL

DAMS & RESERVOIRS

LEVEES OR WALLS

CHANNEL IMPROVEMENTS

WATERSHED TREATMENT

OTHERS

OTHER CORRECTIVE MEASURES

EVACUATION

FLOOD FORECASTING

FLOOD PROOFING

URBAN REDEVELOPMENT

OTHERS

PREVENTIVE MEASURES

FLOOD PLAIN REGULATIONS

ZONING ORDINANCES

SUBDIVISION REGULATIONS

BUILDING CODES

HEALTH REGULATIONS

OTHERS

OTHER PREVENTIVE MEASURES

DEVELOPMENT

OPEN SPACE

AN

WATER

...

PUBLIC INFORMATION AND EDUCATION

FUTURE FLOODS

This section of the report discusses the Standard Project Flood and the Intermediate Regional Flood on Tonawanda Creek and its affected tributaries, and some of the hazards of great floods.

A Standard Project Flood is a severe flood of infrequent occurrence. It is possible, but unlikely, that a flood of greater magnitude can occur. The Standard Project Flood concept was developed by the U. S. Army Corps of Engineers. It provides an indication of the upper limit of flooding in any particular area and is used by the Corps of Engineers to compare floods in different locations throughout the United States.

Those of the size of the Intermediate Regional Flood represent floods that may reasonably be expected to occur more frequently than the Standard Project Flood. Either flood could occur at any time.

Large floods have been experienced in the past on streams in the general geographical region of this study. Heavy storms similar to those causing these floods could occur over the lower Tonawanda Creek watershed. In this event, floods would result on these streams comparable in size with those experienced on neighboring streams. It is therefore desirable, in connection with any determination of future floods which may occur on Tonawanda Creek and its tributaries, to consider storms and floods that have occurred in the region. Table 11 lists the maximum known floods and peak discharges on a square mile basis which have occurred at U.S.G.S. gaging stations in the region of this study area. Although Tonawanda Creek differs in area and terrain from the other streams, the tabulation indicates that larger floods are likely to occur.

TABLE 11
MAXIMUM KNOWN FLOOD DISCHARGES AT
U.S.G.S. GAGING STATIONS
ON STREAMS IN THE REGION
OF TONAWANDA CREEK, NEW YORK

<u>Stream</u>	<u>Location</u> New York	<u>Drainage</u> <u>area</u> sq. mi.	<u>Date</u>	<u>Peak discharge</u> Per	
				<u>Amount</u> cfs	<u>sq. mi.</u> cfs
Cattaraugus Creek	Arcade	78.4	March 5 1964	4,380	56
Cattaraugus Creek	Gowanda	432	March 17 1942	35,900	83
Buffalo Creek	Wales Hollow	80.1	March 5 1964	4,430	55
Buffalo Creek	Gardenville	144	March 1 1955	13,000	90
Cayuga Creek	Lancaster	94.9	January 22 1959	8,750	92
Cazenovia Creek	Ebenezer	134	March 1 1955	13,500	101
Scajaquada Creek	Buffalo	15.9	August 7 1963	2,620	165
Little Tonawanda Cr.	Linden	22.1	March 7 1956	2,700	122
Tonawanda Creek	Batavia	171	March 31 1960	7,200	42
Tonawanda Creek	Alabama	230	April 1 1940	9,000 (1)	39
Tonawanda Creek	Rapids	358	April 1 1960	10,600 (1)(2)	30
Ellicott Creek	Mill Grove	40.7	March 5 1964	1,400	34
Ellicott Creek	Williamsville	72.4	March 31 1960	4,860	67

(1) Estimated by Corps of Engineers.

(2) Includes overflow down Black Creek.

Unfortunately, when data are given pertaining to future floods such as the Intermediate Regional and the Standard Project some people have the opinion that this will probably not happen during their lifetime and have a tendency to ignore the potential problems. Although it is true that the Intermediate Regional Flood has an average frequency of occurrence in the order of once in 100 years and the Standard Project Flood is even less frequent, it must be kept in mind, that either flood can happen in any given year.

The following excerpts from the U.S. Geological Survey Water-Supply Paper 773-E, "The New York State Flood of July 1935," exemplifies the potential disaster which can become a reality at any location and at any time.

"Dead, 43; homeless, hundreds; estimated damage, \$25,000,000; devastated, a farm belt 200 miles long, from Hornell to the Catskill Mountains, 50 to 75 miles wide, from the Pennsylvania border to the Mohawk Valley."

Table 12, taken from the above mentioned report lists the recorded rainfall at stations in south-central New York during the July 1935 storm. This table shows that the rainfall of the 1935 storm very nearly approached the rainfall necessary to produce a Standard Project Flood in the study area. The estimated storm rainfall for the Standard Project Flood at various locations along Tonawanda Creek is shown on page 73.

TABLE 12
RECORDED RAINFALLS DURING JULY 1935

<u>Station</u>	<u>24-hour</u>	<u>48-hour</u>	<u>72-hour</u>
Ithaca	7.90	9.25	9.50
Cortland	7.67	10.58	11.15
Norwich	6.10	9.07	9.56
Delhi	8.52	8.68	9.43
Haskinville	3.35	6.70	6.76
Oneonta	5.24	6.71	6.94
Burdett	8.50	10.50	11.10
Ovid	7.61	9.84	10.61
Hammondsport	6.10	8.00	8.47

Examples of rainfall measured in open receptacles at various locations in the vicinity of Bath, New York during the 7-8 July 1935 storm are 12 inches in 12 hours, 14 inches in 12 hours, and 14 inches in 16 hours. At Rochester, New York an automatic rain-gage recorded these record-breaking intensities during 7 July 1935: 0.91 inches in 10 minutes, 1.25 inches in 15 minutes and 1.98 inches in 30 minutes.

The estimated maximum discharge in New York State during the July 1935 storm was 82,800 cubic feet per second on the Chenango River, near Chenango Forks, New York. This produced a runoff of 56 cubic feet per second over the 1,492 square mile drainage area. The maximum runoff per square mile was estimated to be 2,520 cubic feet per second on Glen Creek near Townsend, New York over a drainage area of 2.91 square miles.

U.S. Weather Bureau "Technical Paper No. 15, Part X: New York" dated December 1954 shows the Maximum Recorded Precipitation for a 12-hour period varies from a high of 6.64 inches during July 1935 at Ithaca to a low of 1.93 inches at Massena during September 1946. Other maximum 12-hour values in Western and Central New York are 3.88 inches at Buffalo during August 1963, 6.17 inches at Bolivar during July 1942, 4.45 inches at Cohocton No. 1 during July 1942 and 4.13 inches at West Almond during July 1942. These values give an indication of the amount of precipitation which has fallen near the study area.

DETERMINATION OF INTERMEDIATE REGIONAL FLOODS

The Intermediate Regional Flood is defined as a flood having an average frequency of occurrence in the order of once in 100 years, at a designated location. This is equal to a 1% chance of occurrence in any year. Some probability estimates are based on statistical analyses of streamflow records available for the watershed under study, but limitations in such records usually require analyses of rainfall and runoff characteristics in the "general region" of the area under study. The Intermediate Regional Flood represents a major flood, although it is much less severe than the Standard Project Flood.

In order to determine the Intermediate Regional Floods for Tonawanda, lower Ransom, Black and Mud Creeks in Erie and Niagara Counties, New York, statistical studies were made using the 45-year record of known flood data for Tonawanda Creek at Hopkins Road, Alabama, New York.

Results of the studies indicate that the Intermediate Regional flood on Tonawanda Creek at the Alabama gaging station would have a

peak discharge of 11,500 cubic feet per second, and a peak discharge of 16,000 cfs upstream of the confluence of Tonawanda Creek and Ellicott Creek in the city of Tonawanda. Peak discharges of the Intermediate Regional Flood along Tonawanda Creek are shown in table 13, these peak discharges include tributary and overbank flows.

TABLE 13
INTERMEDIATE REGIONAL FLOOD
PEAK DISCHARGES

<u>Location</u>	<u>Stream Mile</u>	<u>Drainage Area sq. mi.</u>	<u>Discharge cfs</u>
Upstream from Confluence with Ellicott Creek	0.3	525	16,000
Rapids, New York	18.7	358	13,500
Alabama, New York	41.5	230	11,500

Intermediate Regional Floods may occur on Tonawanda Creek in the reach investigated that would be from about 1 to 2 feet higher than the 1960 flood, generally considered the most damaging flood under present conditions. On lower Ransom and Black Creeks, an Intermediate Regional Flood would be about 0.5 to 1.5 feet higher than the 1960 flood, while on Mud Creek it would be about 0.4 to 1.0 feet higher than the 1960 flood.

DETERMINATION OF STANDARD PROJECT FLOODS

Only in rare instances has a specific stream experienced the largest flood that can be expected to occur. Severe as the maximum known flood may have been on any given stream, it is a commonly accepted fact that, in practically all cases, sooner or later a larger flood can and probably will occur. The Corps of Engineers, in cooperation with the Weather Bureau, has made broad and comprehensive studies and investigations based on the vast records of experienced storms and floods and has evolved generalized procedures for estimating the flood potential of streams. These procedures have been used in determining the Standard

Project Flood. It is defined as the largest flood that can be expected from the most severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographical region involved.

Standard Project Flood estimates made along Tonawanda Creek indicate storm rainfall would be approximately 11.5 inches in the city of Tonawanda, 12.0 inches at Rapids and 12.4 inches at Alabama, all within a 96-hour period. Because the Standard Project Flood elevations cause Tonawanda, lower Ransom, Black and Mud Creeks to become one large common pool, the peak discharges given in table 14 include tributary and overbank flows.

TABLE 14
STANDARD PROJECT FLOOD
PEAK DISCHARGES

<u>Location</u>	<u>Stream Mile</u>	<u>Drainage Area sq. mi.</u>	<u>Discharge cfs</u>
Upstream from Confluence of Ellicott Creek	0.3	525	63,000
Rapids, New York	18.7	358	50,000
Alabama, New York	41.5	230	35,200

Frequency

It is not practical to assign a frequency to the Standard Project Flood. The occurrence of such a flood would be a very rare event; however, it could occur in any year.

Possible Larger Floods

Floods larger than the Standard Project Flood are possible; however, the combination of factors that would be necessary to produce such floods would seldom occur. The consideration of floods of this magnitude is of greater importance in some problems than in others but should not be overlooked in the study of any problems.

HAZARDS OF GREAT FLOODS

The amount and extent of damage caused by any flood depends in general upon how much area is flooded, the height of flooding, the velocity of flow, the rate of rise, and the duration of flooding.

Areas Flooded and Heights of Flooding

The areas along Tonawanda, lower Ransom, Black and Mud Creeks flooded by the Standard Project Flood and the Intermediate Regional Flood are shown on plates 5 through 7. Depths of flow for the Standard Project Flood, the Intermediate Regional Flood and the 1960 flood can be estimated from the crest profiles which are shown on plates 8 through 11.

The 1960 flood profiles for the streams are based on actual high water marks, while the Intermediate Regional and Standard Project Floods were computed by using stream characteristics for selected reaches as determined from observed flood profiles, topographic maps, and valley cross sections. The overflow areas shown on plates 5 through 7 and the elevations shown on plates 8 through 11 have been determined with an accuracy consistent with the purpose of this study and the accuracy of the available basic data. The Standard Project Flood overflow in the urban areas should be considered to be indicative only because of the effects of buildings, railroad fills, etc. The profiles of the Standard Project Flood and the Intermediate Regional Flood depend in part upon the degree of destruction or clogging of various bridges during the flood. Because it is impossible to forecast these events, it was assumed that all bridge structures would stand, and that no clogging would occur. However, should any of these events occur, the profiles shown for the Intermediate Regional Flood and the Standard Project Flood could be higher.

The Standard Project Flood profile for Tonawanda Creek is approximately 2 feet higher at Alabama to about 8 feet higher at the city of Tonawanda than the 1960 flood. The maximum difference occurs at the

at the downstream limit of the study area and is a result of narrowing of the flood plain. The Standard Project Flood profile for lower Ransom Creek varies from less than 2 feet near Hopkins Road in the town of Amherst, to about 6 feet higher at its mouth than the 1960 flood. The Standard Project Flood on lower Ransom Creek below Hopkins Road in the town of Amherst is affected by backwater from Tonawanda Creek. The Standard Project Flood profile for Black Creek averages about 2 feet higher than the 1960 flood with some locations having a difference of less than 1 foot. Crest profiles for the Standard Project Flood on Mud Creek show that it could vary from a high of about 5 1/2 feet above the 1960 flood at Minnick Road to about 2 feet higher at the upper end of the study area near the old Lewiston Road.

The Intermediate Regional Flood profile for Tonawanda Creek is approximately 1 to 2 feet higher than the 1960 flood. Along lower Ransom Creek and Black Creek, the Intermediate Regional Flood is approximately 0.5 to 1.5 feet higher than the 1960 flood. On Mud Creek it is about 0.4 to 1.0 feet higher than the 1960 flood.

Figures 37 through 46 on pages 76 through 80 show the approximate heights that would be reached by the Standard Project Flood, the Intermediate Regional Flood and the 1960 flood at various locations and on structures presently existing within the flood plain covered by this report.

Elevations for the Intermediate Regional and the Standard Project Floods should be considered in all future planning, especially in this area because of the small difference between normal and extreme floods. Because the flood plain is wide, and flooding relatively shallow, it is possible to get complete protection from future flooding by using the Standard Project Flood elevations as a basis. A good example of this is shown in figure 44 on page 79.



Figure 37. MARINE SALES & SERVICE - TONAWANDA CREEK. The flood heights for the Standard Project Flood and the Intermediate Regional Flood are indicated by arrows at a Marine Sales and Service building near mile 0.9 along Tonawanda Creek.

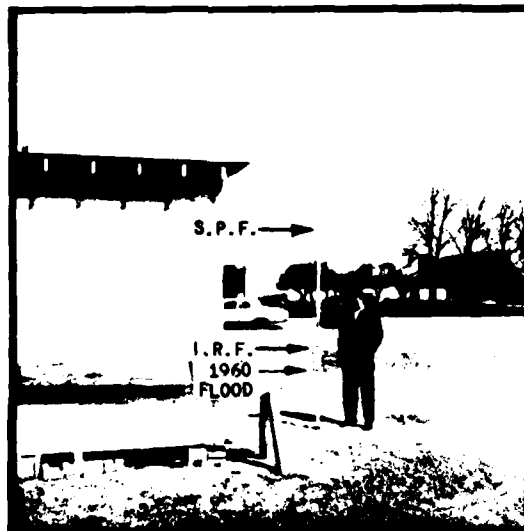


Figure 38. PARK AND MARINA - TONAWANDA CREEK. The flood heights for the Standard Project, Intermediate Regional and the 1960 flood are shown at the Niagara County West Canal Park and Marina near mile 5.2 along Tonawanda Creek.



Figure 39. KOEPEL ROAD - TONAWANDA CREEK
Arrows indicate the height of the Standard Project and Intermediate Regional Floods at a Koepsel Rd. residence located near mile 36.5 along Tonawanda Creek.



Figure 40. ROUTE 268 AND BRAUER RD. - TONAWANDA CREEK. The flood heights for the Standard Project, Intermediate Regional and the 1960 flood are shown near the intersection of Route 269 and Brauer Rd. at mile 21.3 along Tonawanda Creek.



Figure 41. COTTAGE NEAR MOUTH OF RANSOM CREEK
The Standard Project, Intermediate Regional and 1960 flood heights are shown on a cottage near the mouth of Ransom Creek.



Figure 42. HOPKINS ROAD - RANSOM CREEK
The flood heights for the Standard Project, Intermediate Regional and the 1960 flood are indicated by the arrows shown on a telephone pole at Hopkins Rd. near mile 1.8 along Ransom Creek.



Figure 43. WESTFAILINGER ROAD - BLACK CREEK
The relative flood heights for the Standard Project, Intermediate Regional and the 1960 flood are indicated by arrows at the Westfailinger Rd. bridge at mile 5.9 over Black Creek.



Figure 44. ST. PAULS LUTHERAN CHURCH - BLACK CREEK. The height of the Standard Project Flood would be approximately at the base of St. Pauls Lutheran Church near mile 8.8 along Black Creek. Construction upon fill such as this will prevent flood damage.



Figure 45. CONFLUENCE OF TONAWANDA & MUD CREEKS
The relative flood heights for the Standard Project, Intermediate Regional and the 1960 flood are indicated at a residence near the confluence of Tonawanda Creek and Mud Creek.



Figure 46. MOBILE HOME PARK - MUD CREEK
The height of the Standard Project flood is indicated by an arrow at a Mobile Home Park along Mud Creek near mile 2.5. Most of the 75 trailers in the park would be destroyed by this flood.

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FLOOD PLAIN INFORMATION, TONAWANDA CREEK AND ITS AFFECTED TRIBU—ETC(U)
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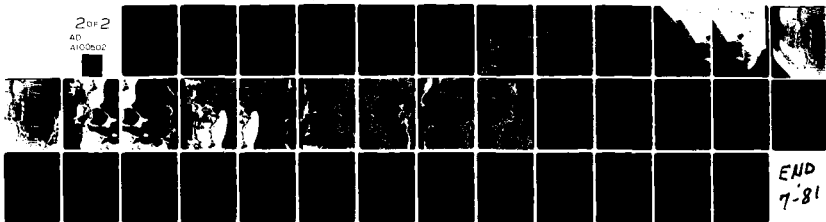
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Velocities, Rates of Rise, and Duration

Water velocities during floods depend largely upon the size and shape of the cross section, the conditions of the stream, and the bed slope, all of which vary on different streams and at different locations on the same stream.

Table 15 lists the velocities that would occur in the main channel and overbank areas along Tonawanda Creek during the Intermediate Regional Flood.

TABLE 15
INTERMEDIATE REGIONAL FLOOD
VELOCITIES

<u>Location</u>	<u>Stream Mile</u>	<u>Velocities</u>	
		<u>Channel</u> ft. per sec.	<u>Overbank</u> ft. per sec.
Upstream from Confluence with Ellicott Creek	0.3	8	2
Rapids, New York	18.7	7	3
Alabama, New York	41.5	10	2

Table 16 lists the velocities that would occur in the main channel and overbank areas along Tonawanda Creek during the Standard Project Flood.

TABLE 16
STANDARD PROJECT FLOOD
VELOCITIES

<u>Location</u>	<u>Stream Mile</u>	<u>Velocities</u>	
		<u>Channel</u> ft. per sec.	<u>Overbank</u> ft. per sec.
Upstream from Confluence with Ellicott Creek	0.3	10	3
Rapids, New York	18.7	8	4
Alabama, New York	41.5	12	3

Table 17 lists the total rise above low water to the crest of the Intermediate Regional Flood, the maximum rate of rise, and the duration above bankfull stage of the Intermediate Regional Flood along Tonawanda Creek. The duration above bankfull stage is based on the assumption that this storm was caused by rainfall and does not include prolonged runoff from snowmelt and high stages caused by ice jams, etc. The 4-foot rise near the mouth of Ellicott Creek shown in table 17 is caused by discharges of Tonawanda Creek and its tributaries. However, under certain conditions it is possible for Niagara River waters to attain this same elevation at the lower end of Tonawanda Creek.

TABLE 17
INTERMEDIATE REGIONAL FLOOD
RATES OF RISE AND DURATION

<u>Location</u>	<u>Stream Mile</u>	<u>Height of Rise feet</u>	<u>Time of Rise hours</u>	<u>Maximum Rate of Rise ft. per hr.</u>	<u>Duration above Bankfull hours</u>
Upstream from Confluence with Ellicott Creek	0.3	4	48	0.3	30
Rapids, New York	18.7	16	48	0.3	72
Alabama, New York	41.5	9	40	0.4	64

Table 18 lists the total rise above low water to the crest of the Standard Project Flood, the maximum rate of rise, and duration above bankfull stage of the Standard Project Flood along Tonawanda Creek. The duration above bankfull is based on the assumption that the flood was caused by excessive rainfall only.

TABLE 18
STANDARD PROJECT FLOOD
RATES OF RISE AND DURATION

<u>Location</u>	<u>Stream Mile</u>	<u>Height of Rise feet</u>	<u>Time of Rise hours</u>	<u>Maximum Rate of Rise ft. per hr.</u>	<u>Duration above Bankfull hours</u>
Upstream from Confluence with Ellicott Creek	0.3	8	54	0.4	66
Rapids, New York	18.7	17	54	0.4	108
Alabama, New York	41.5	10	54	0.6	102

These rates of rise and high stream velocities in combination with deep, fairly long-duration flooding would create a hazardous situation in developed areas. Velocities greater than three feet per second combined with depths of three feet or greater are generally considered hazardous.

GLOSSARY OF TERMS

Flood. An overflow of lands not normally covered by water and that are used or usable by man. Floods have two essential characteristics: The inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river or stream or an ocean, lake, or other body of standing water.

Normally a "flood" is considered as any temporary rise in stream flow or stage, but not the ponding of surface water, that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situations by deposition of materials in stream channels during flood recessions, rise of ground water coincident with increased stream flow, and other problems.

Flood Crest. The maximum stage or elevation reached by the waters of a flood at a given location.

Flood Peak. The maximum instantaneous discharge of a flood at a given location. It usually occurs at or near the time of the flood crest.

Flood Plain. The relatively flat area or low lands adjoining the channel of a river, stream or watercourse or ocean, lake, or other body of standing water, which has been or may be covered by flood water.

Flood Profile. A graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

Flood Stage. The stage or elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured.

Head Loss. The effect of obstructions, such as narrow bridge openings or buildings that limit the area through which water must flow, raising the surface of the water upstream from the obstruction.

Intermediate Regional Flood. A flood having an average frequency of occurrence in the order of once in 100 years although the flood may occur in any year. It is based on statistical analyses of streamflow records available for the watershed and analyses of rainfall and runoff characteristics in the "general region of the watershed."

Left Bank. The bank on the left side of a river, stream, or water course, looking downstream.

Low Steel (or Underclearance). See "underclearance."

Right Bank. The bank on the right side of a river, stream, or water course, looking downstream.

Standard Project Flood. The flood that may be expected from the most severe combination of meteorological and hydrological conditions that is considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations. Peak discharges for these floods are generally about 40% to 60% of the Probable Maximum Floods for the same basins. Such floods, as used by the Corps of Engineers, are intended as practicable expressions of the degree of protection that should be sought in the design of flood control works, the failure of which might be disastrous.

Underclearance. The lowest point of a bridge or other structure over or across a river, stream, or water course that limits the opening through which water flows. This is referred to as "low steel" in some regions.

AUTHORITY, ACKNOWLEDGMENTS, AND INTERPRETATION OF DATA

This report has been prepared in accordance with the authority granted by Section 206 of the Flood Control Act of 1960 (PL 86-645), as amended.

* * *

The cooperation and assistance given by the following agencies and numerous private citizens, in the accumulation of the information used in this report is greatly appreciated.

All town, city and county governments within the study area

Department of Agricultural Economics, Cornell University

Erie County Department of Planning

Erie County Department of Public Works

New England - New York Inter-Agency Committee

New York State Department of Public Works

New York State Water Resources Commission

U.S. Geological Survey

U.S. Weather Bureau

Buffalo Courier Express

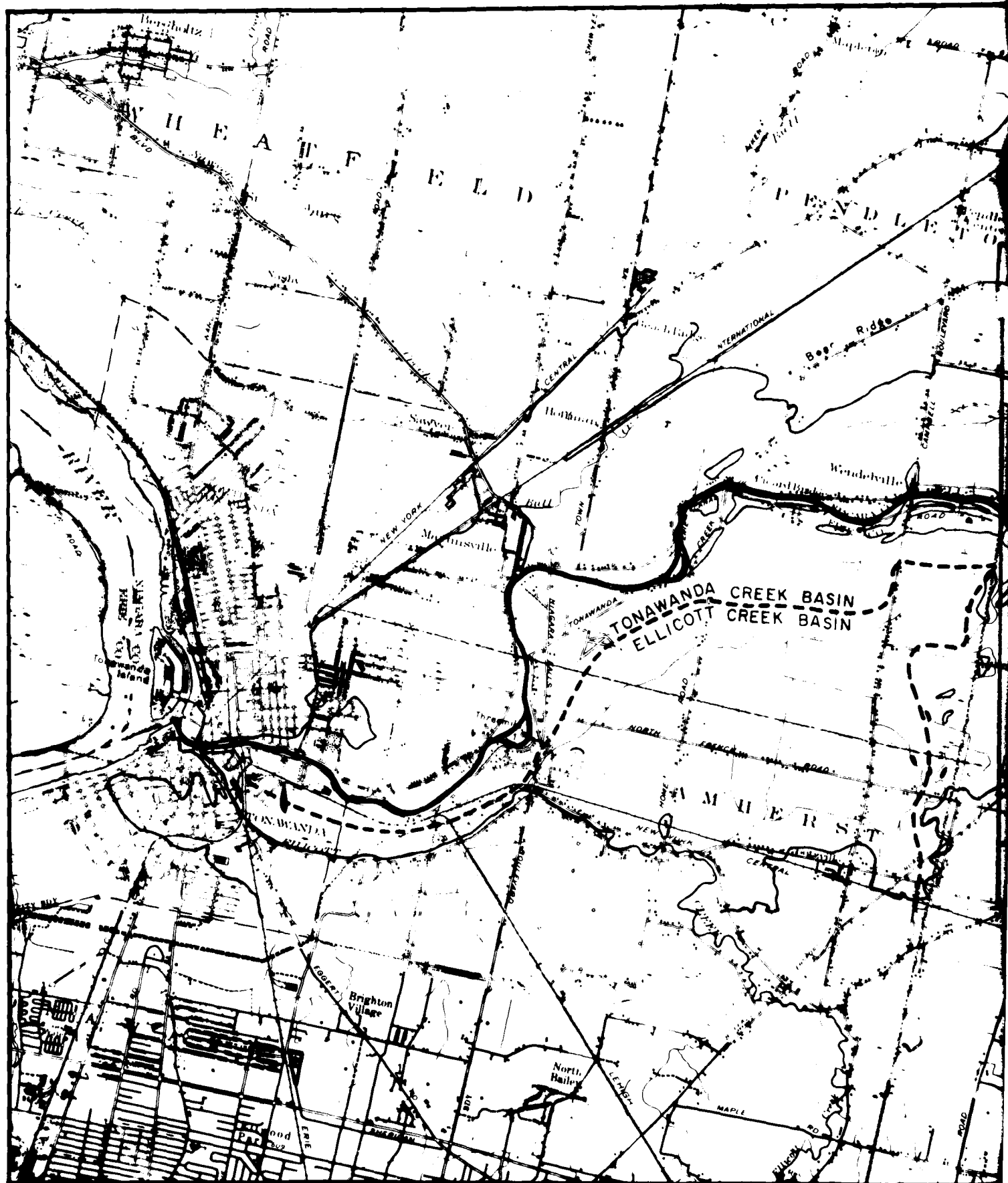
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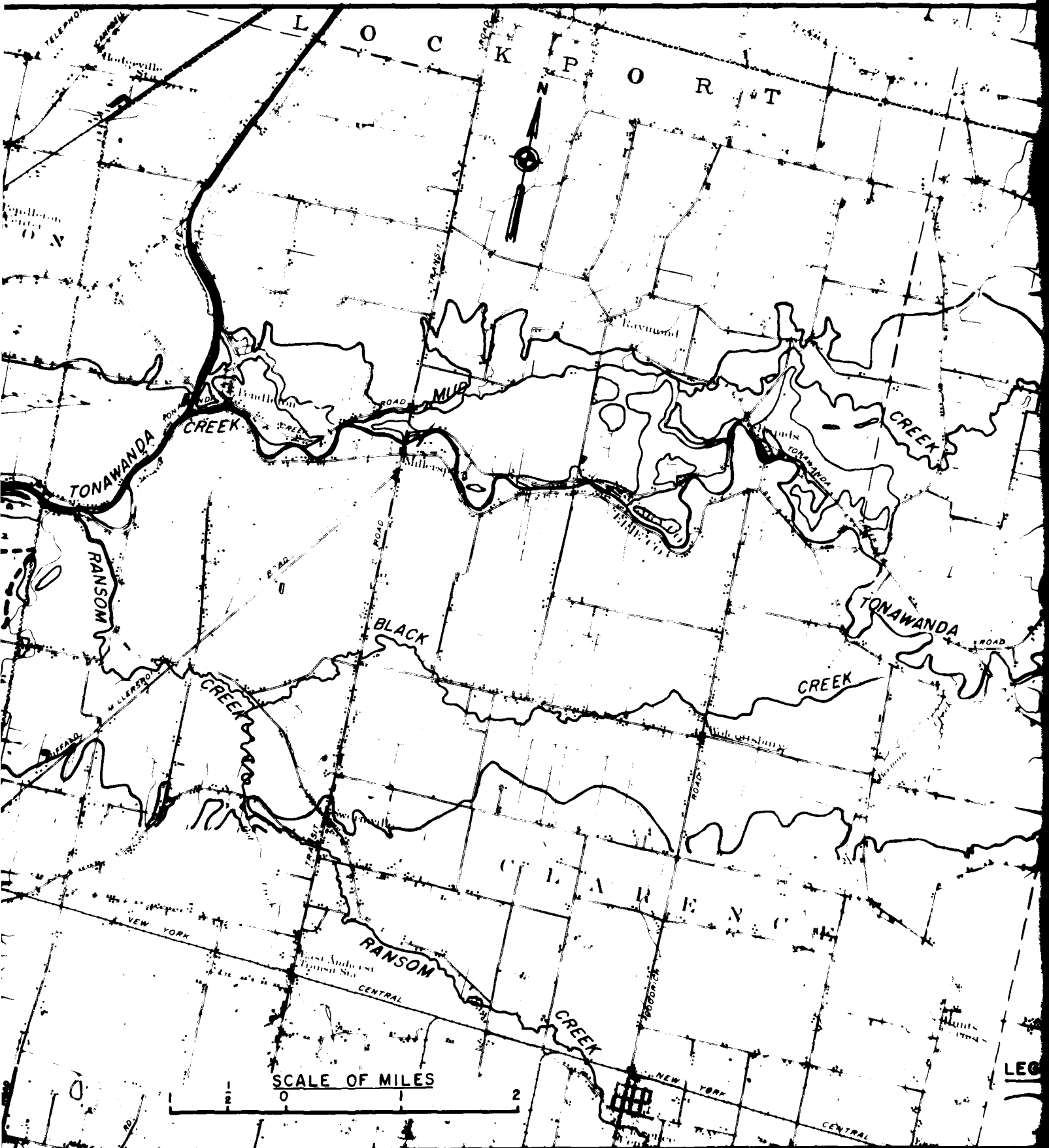
Clarence Press

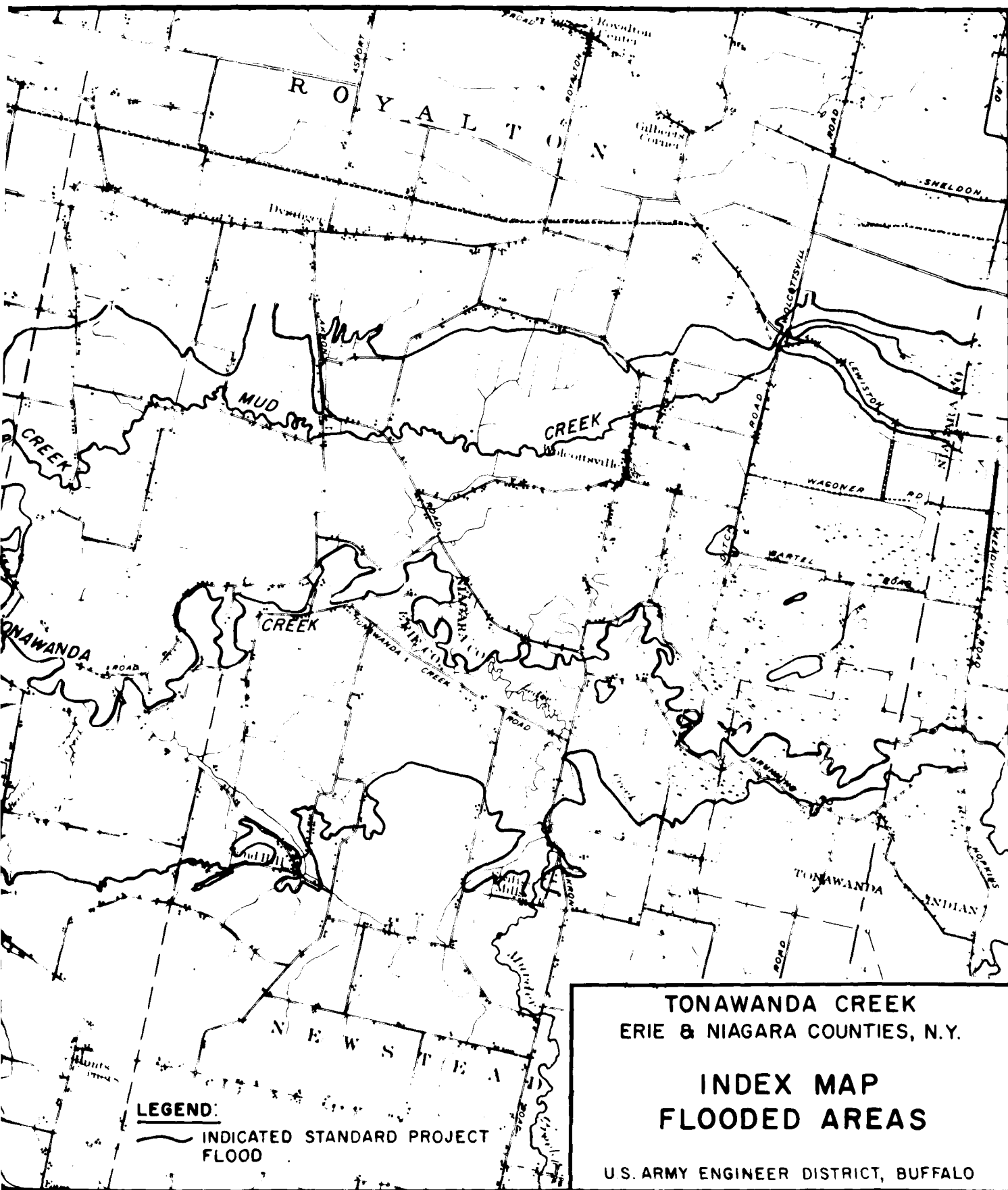
Lockport Union Sun & Journal

* * *

This report presents the flood situation caused by Tonawanda Creek and its affected tributaries within Erie and Niagara Counties, New York. The Buffalo District of the Corps of Engineers will provide interpretation and limited technical assistance in application of the data presented herein.







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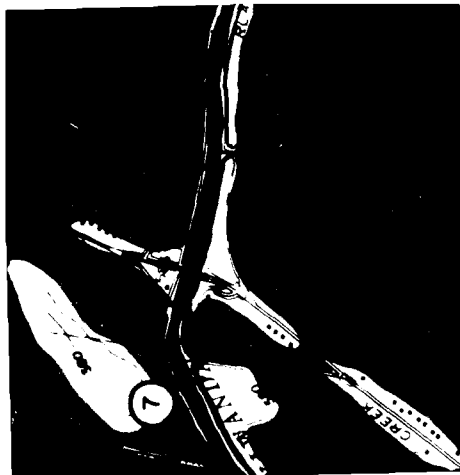
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- INTERMEDIATE REGIONAL FLOOD
- ⑥ DISTANCE FROM MOUTH IN MILES
- △ STAFF GAGE

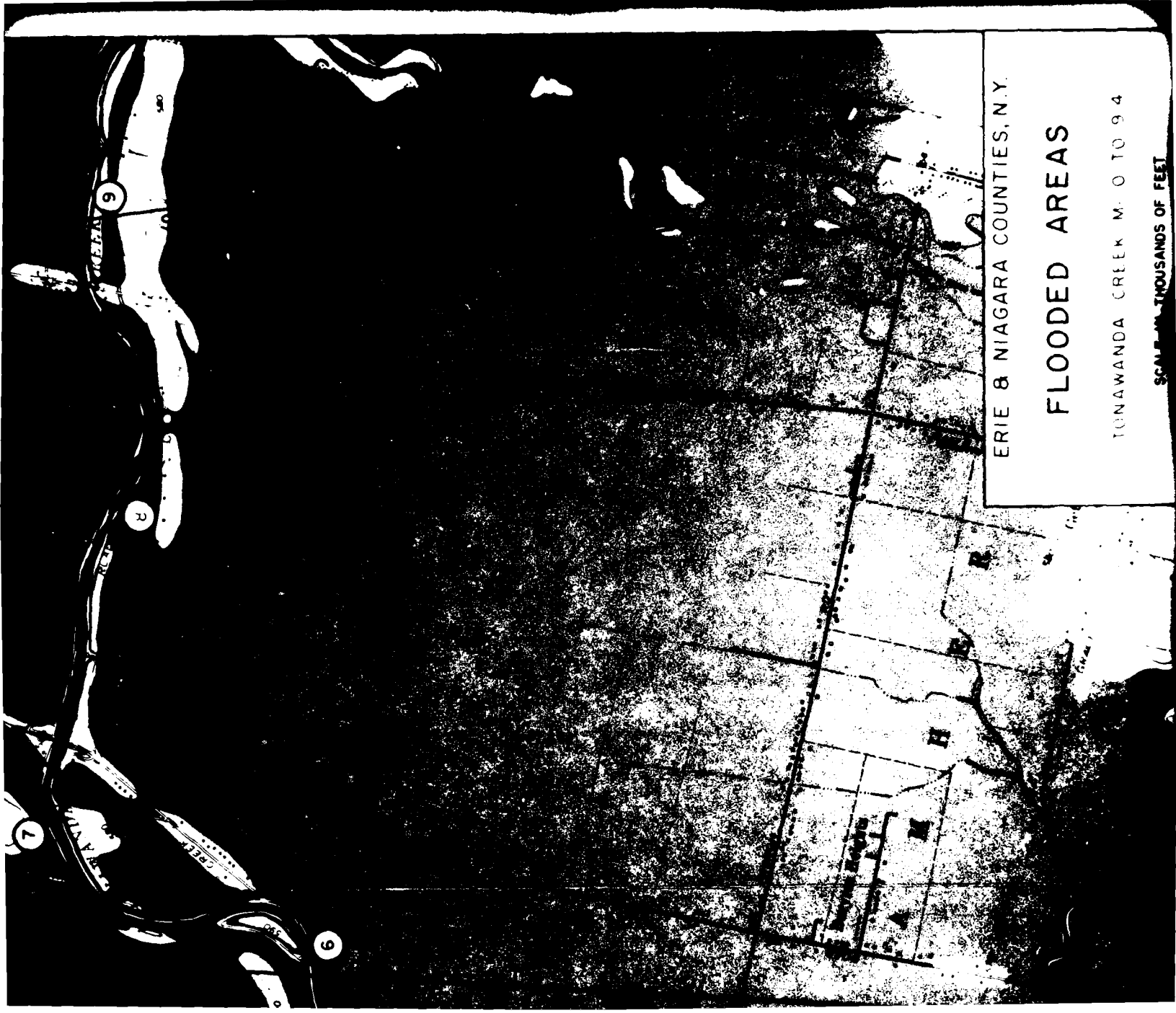
SECTION B LOCATION OF VALLEY CROSS SECTION

LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE REPORT.









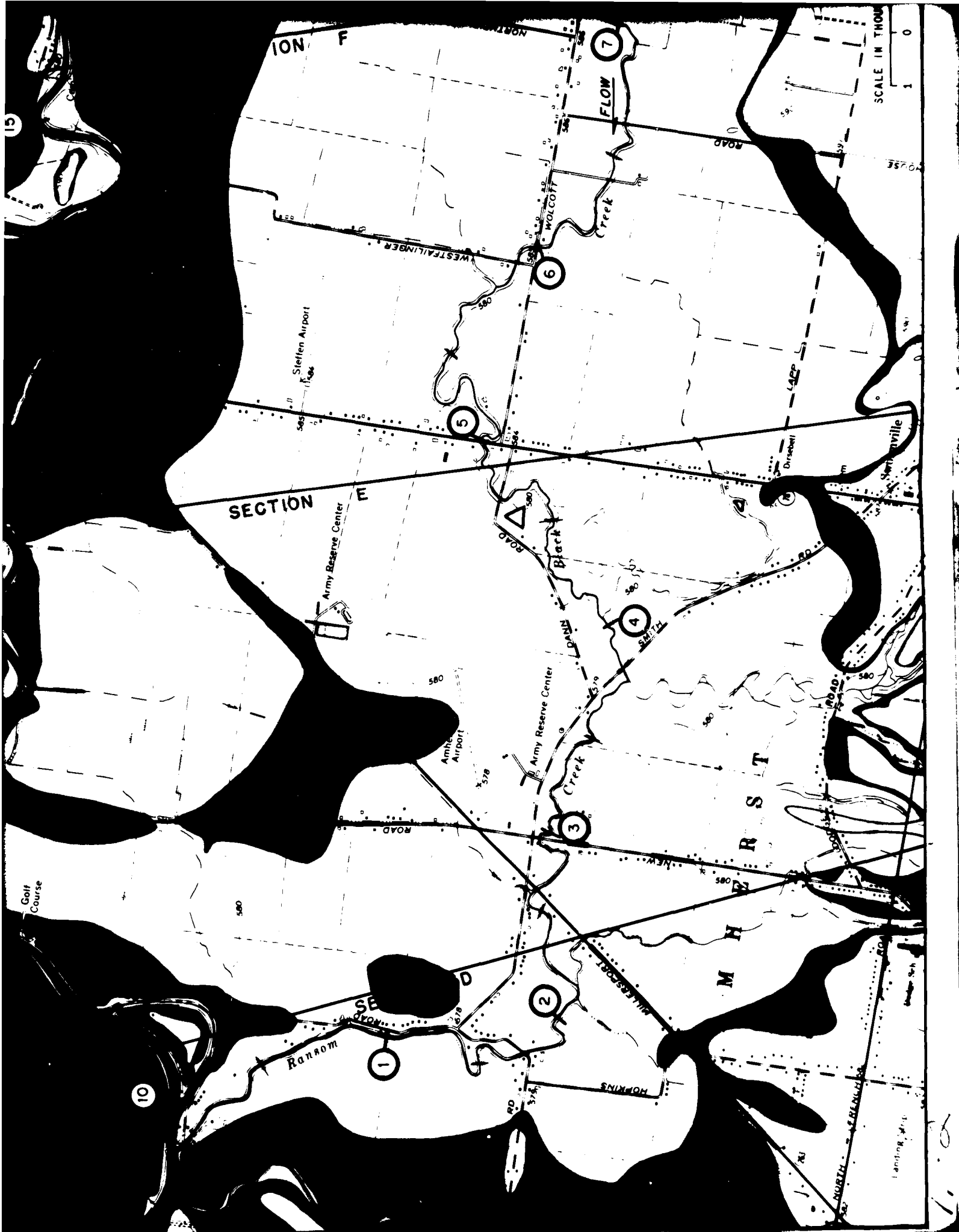
ERIE & NIAGARA COUNTIES, N.Y.

FLOODED AREAS

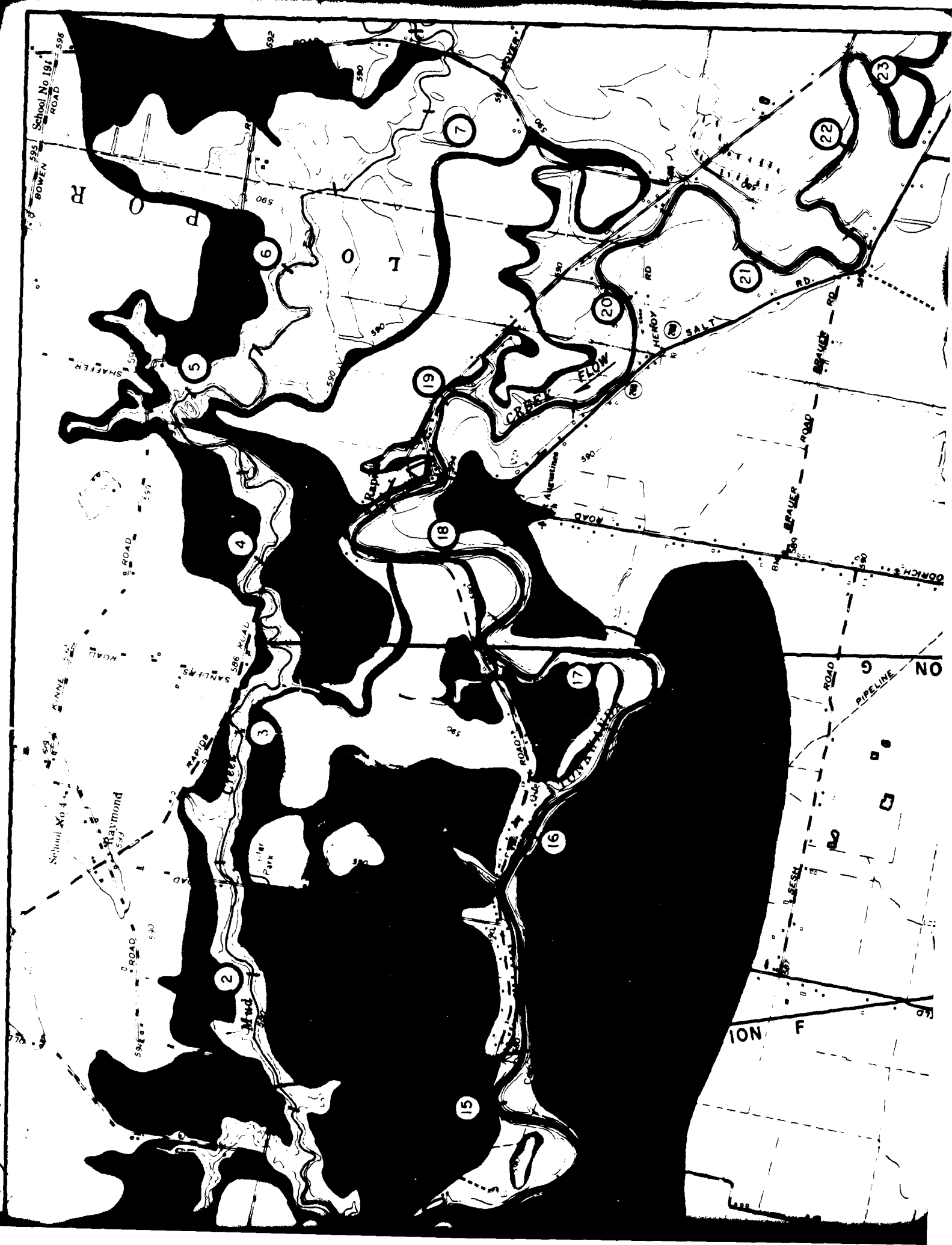
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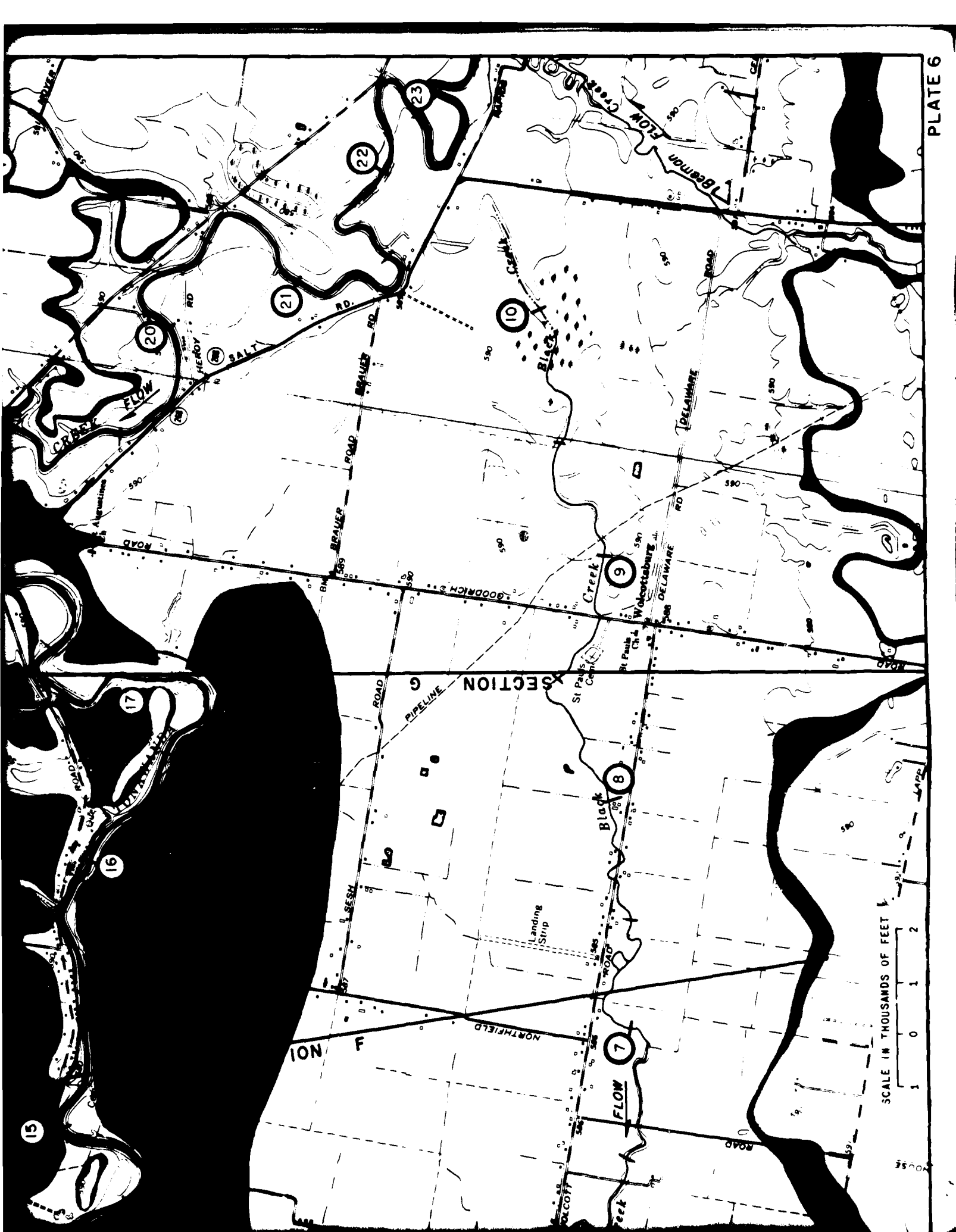
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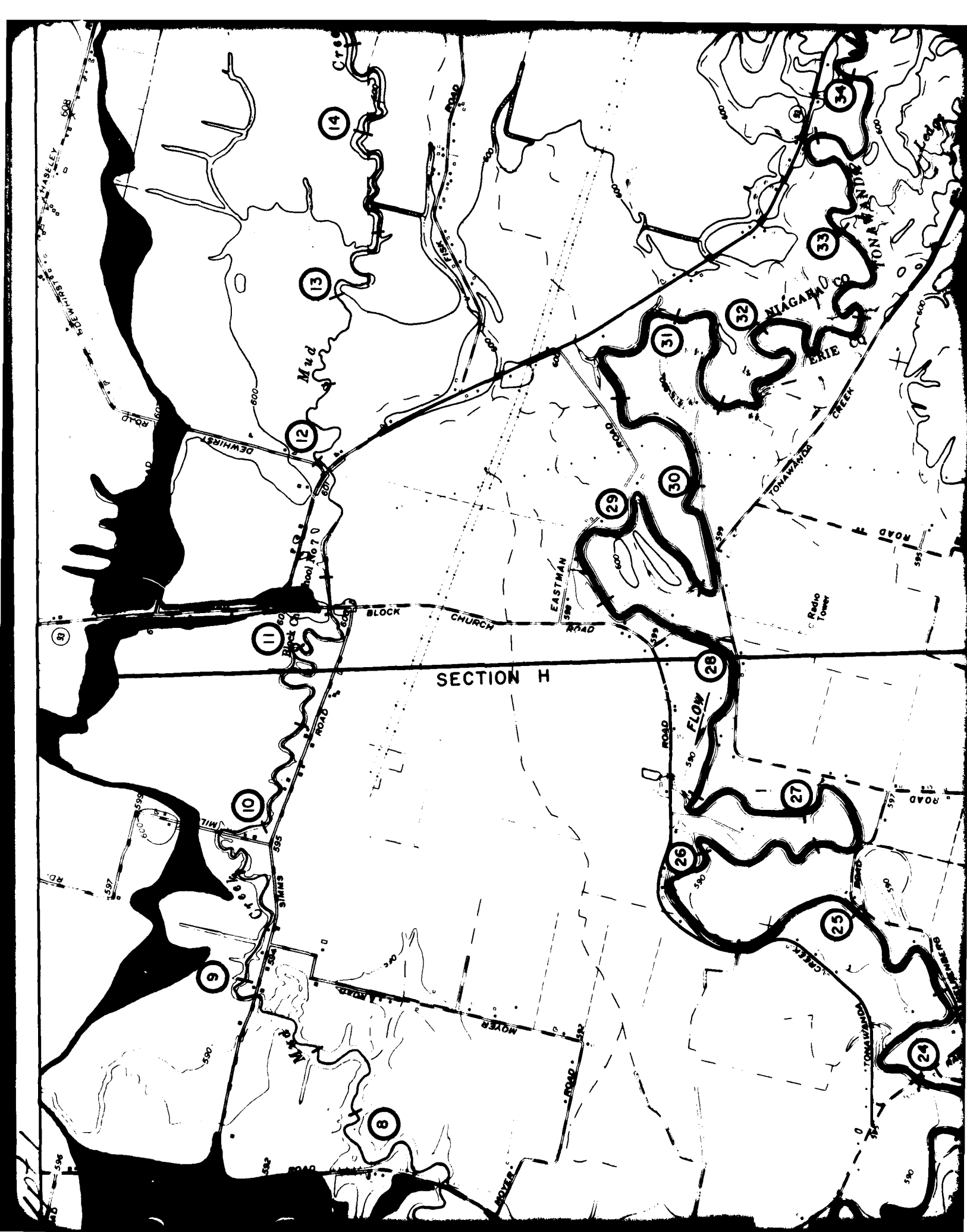


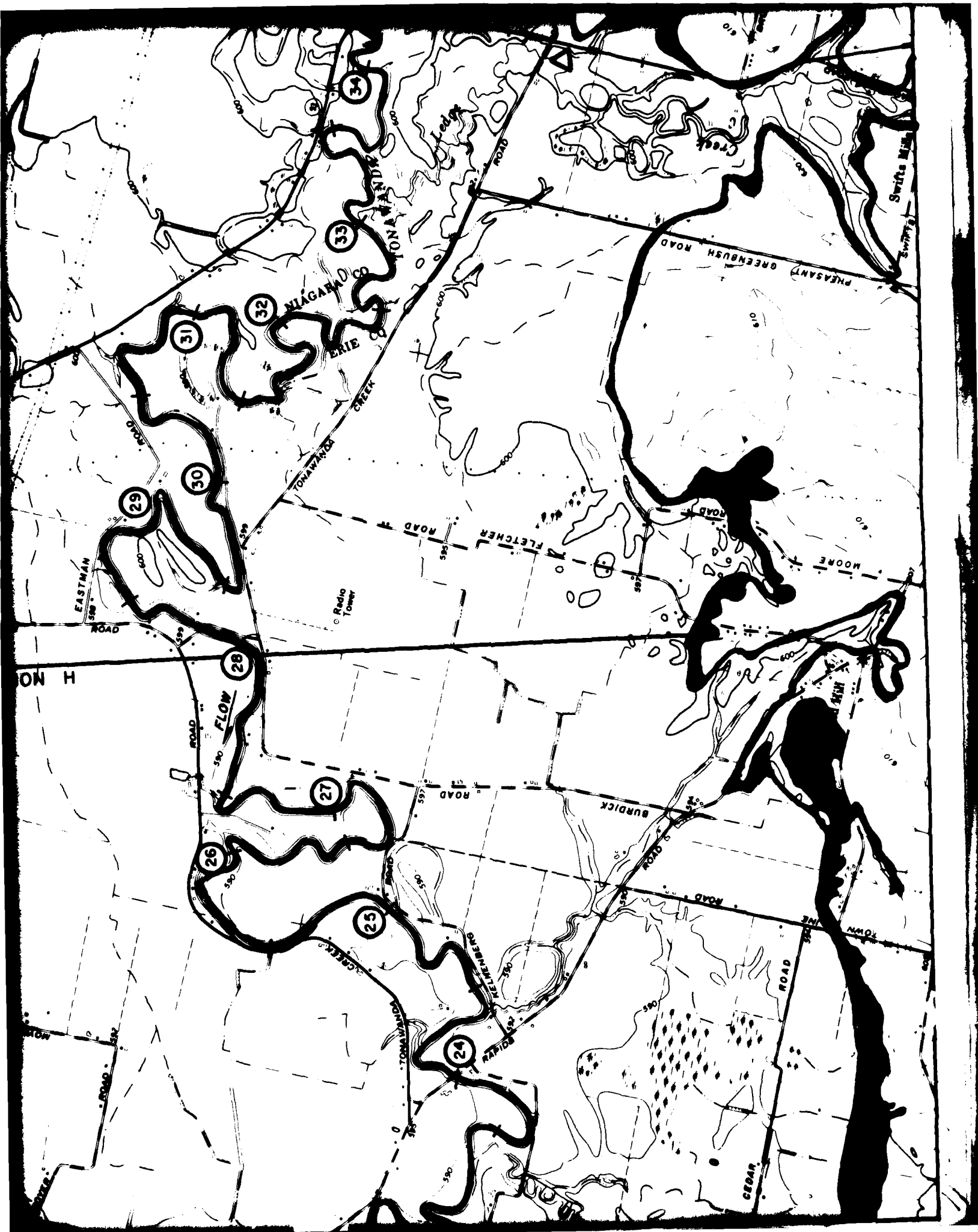


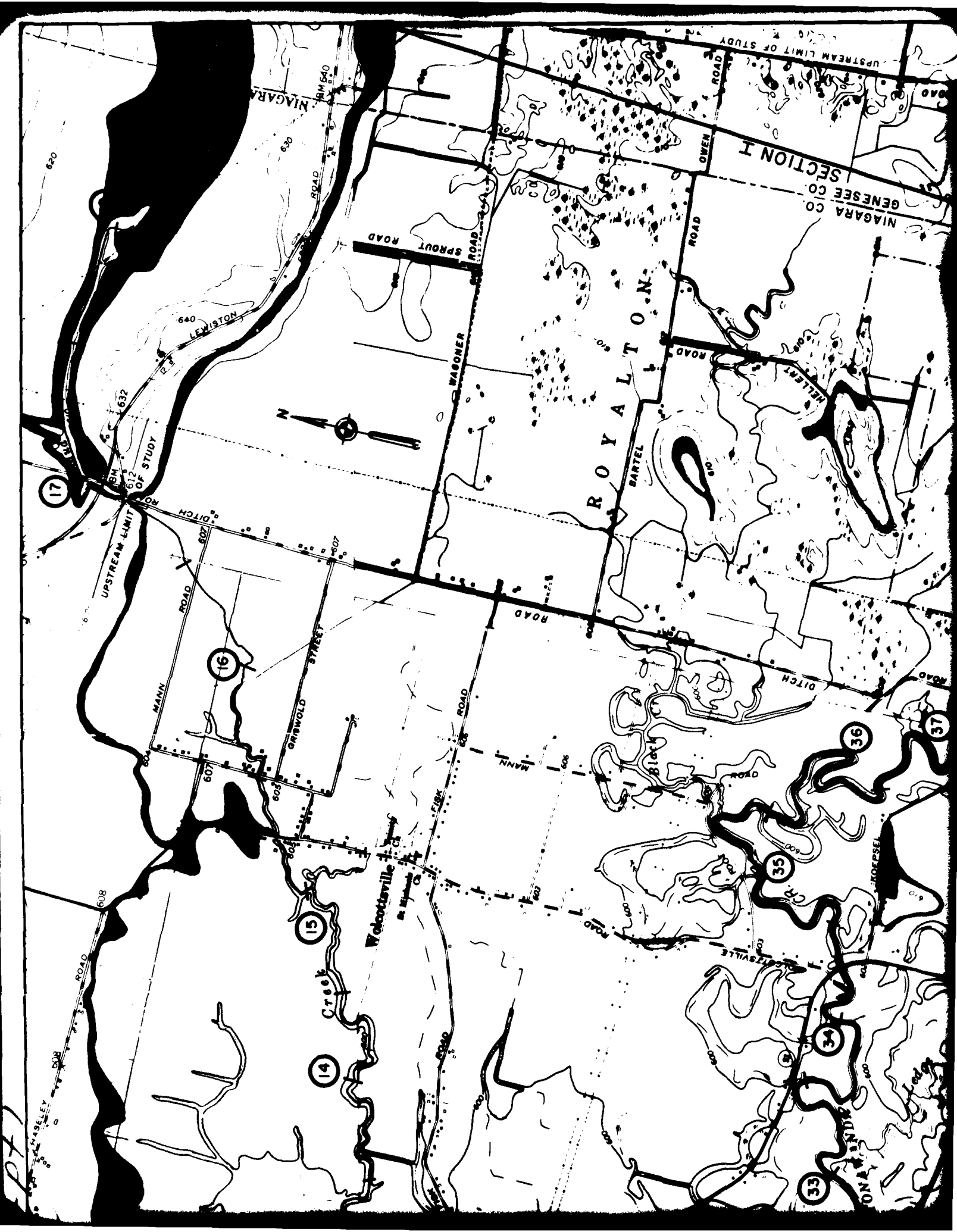
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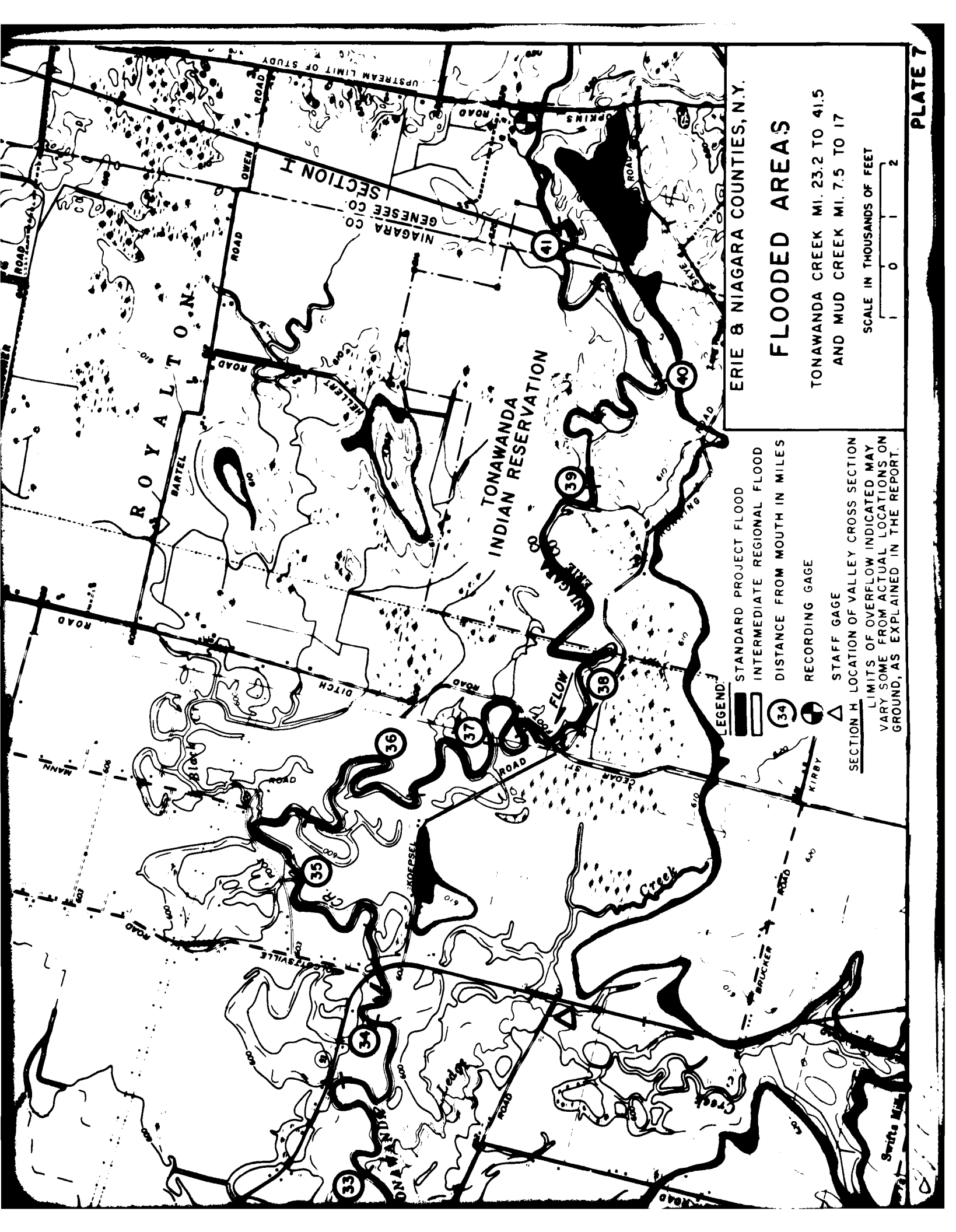












ERIE & NIAGARA COUNTIES, N.Y.

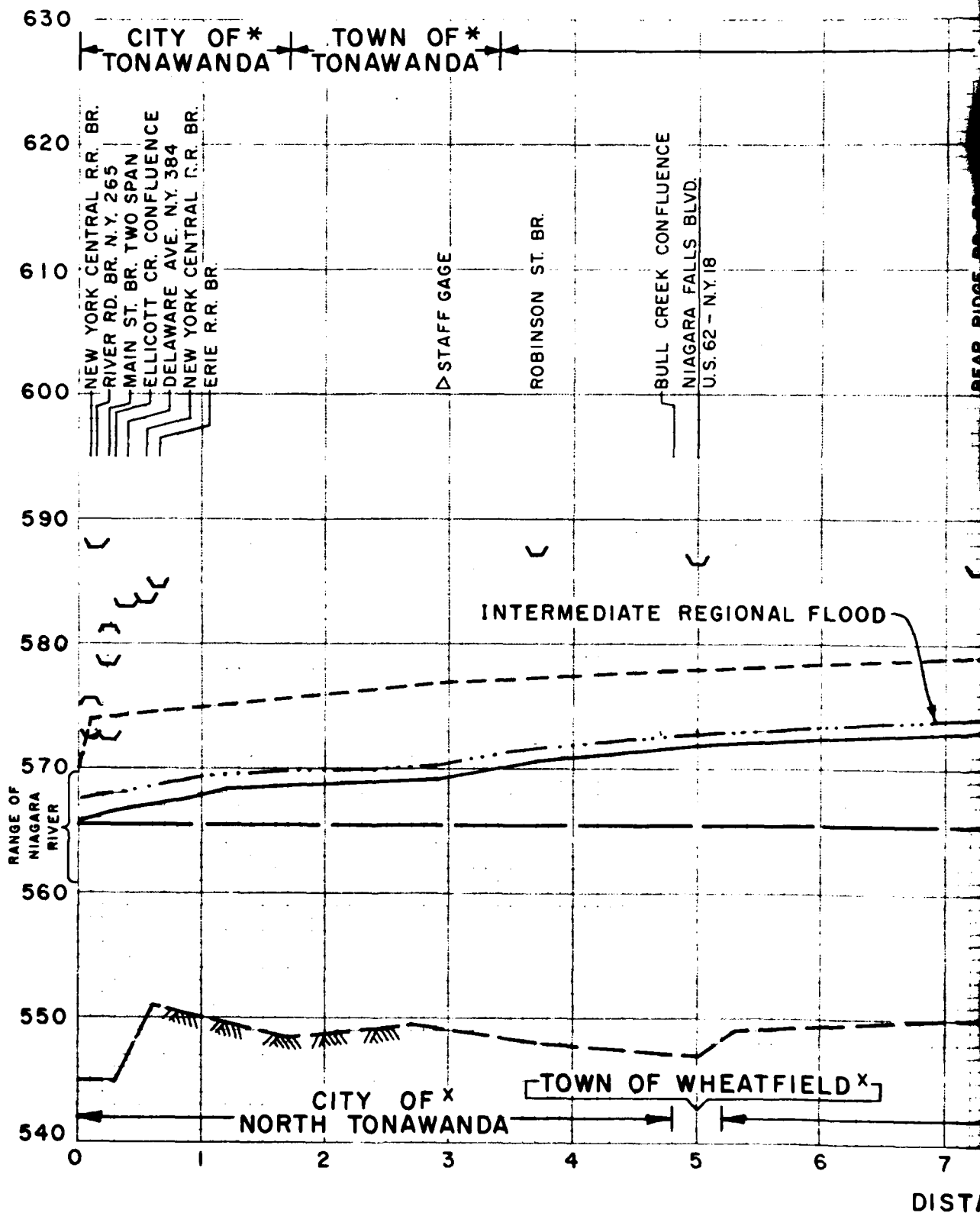
FLOODED AREAS

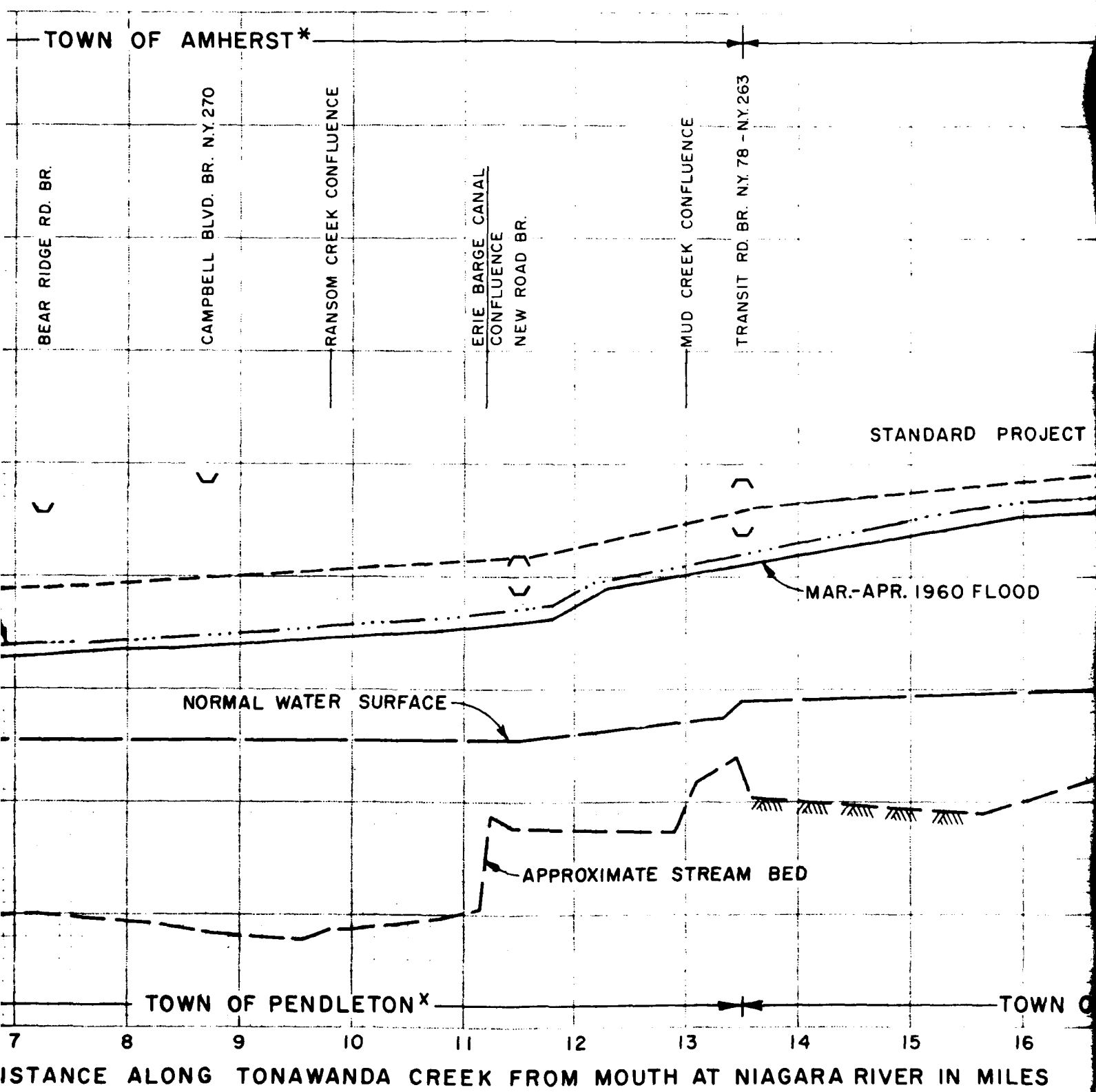
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AND MUD CREEK MI. 7.5 TO 17

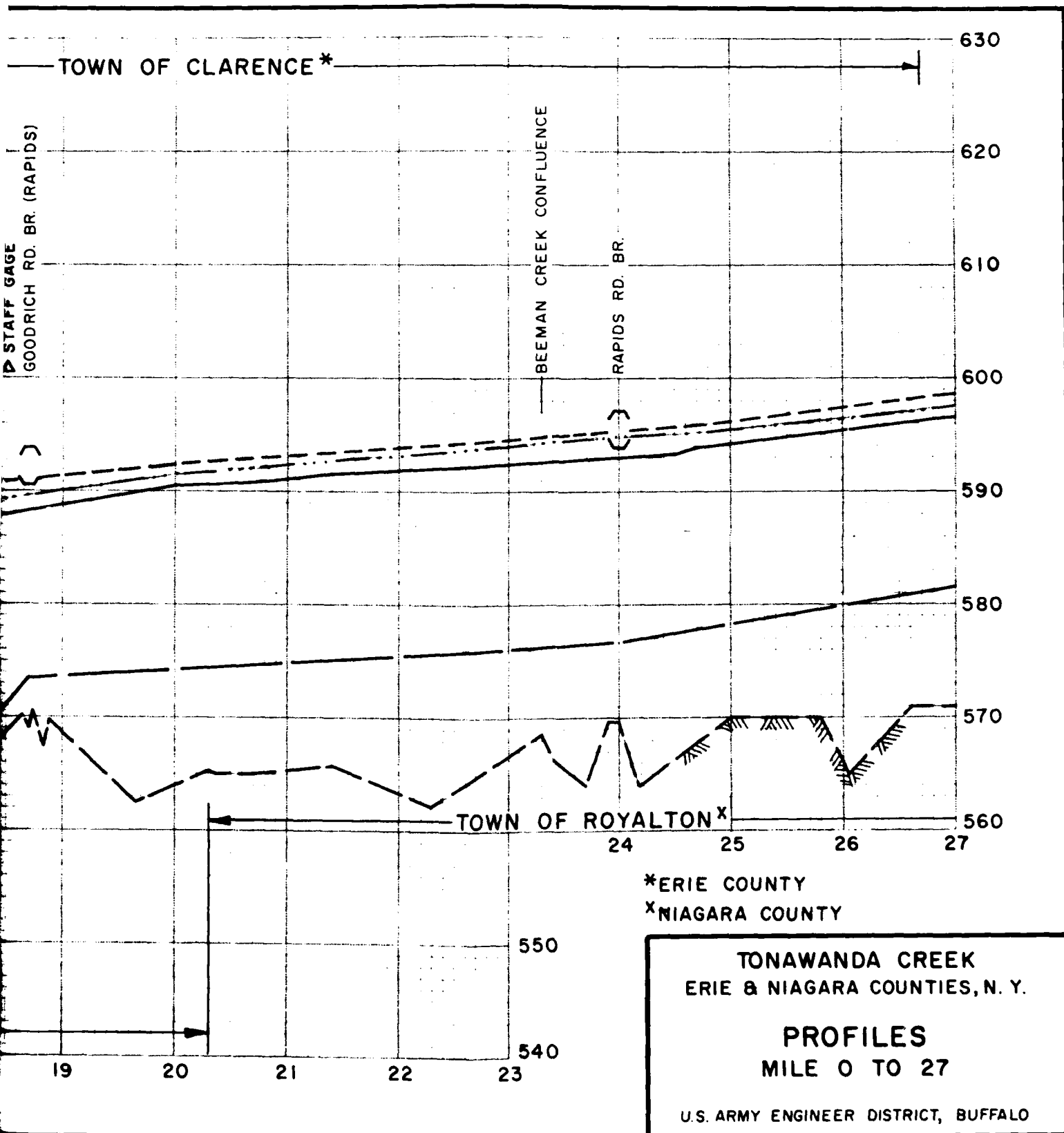
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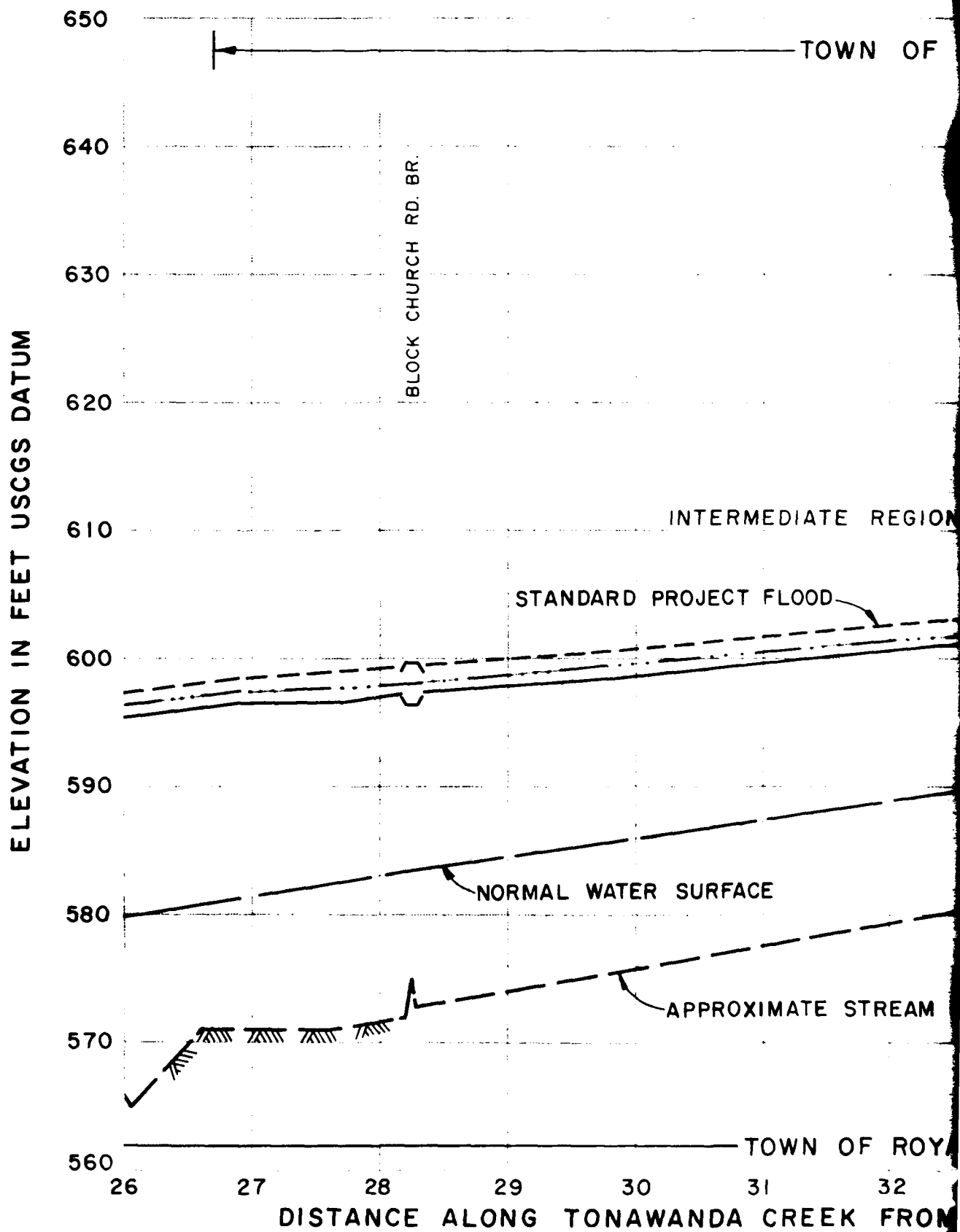
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 - INTERMEDIATE REGIONAL FLOOD
 - DISTANCE FROM MOUTH IN MILES
 - RECORDING GAGE
 - STAFF GAGE
 - SECTION H LOCATION OF VALLEY CROSS SECTION
 - LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE REPORT.

ELEVATION IN FEET USCGS DATUM









OF NEWSTEAD*

TONAWANDA**
INDIAN RESERVATION

LEDGE CREEK CONFLUENCE

AKRON RD. BR. N.Y. 93

FOOT RD. BR.

ERIE & NIAGARA COUNTIES
GENESEE COUNTY

REGIONAL FLOOD

MAR.-APR. 1960 FLOOD

REAM BED

ROYALTON*

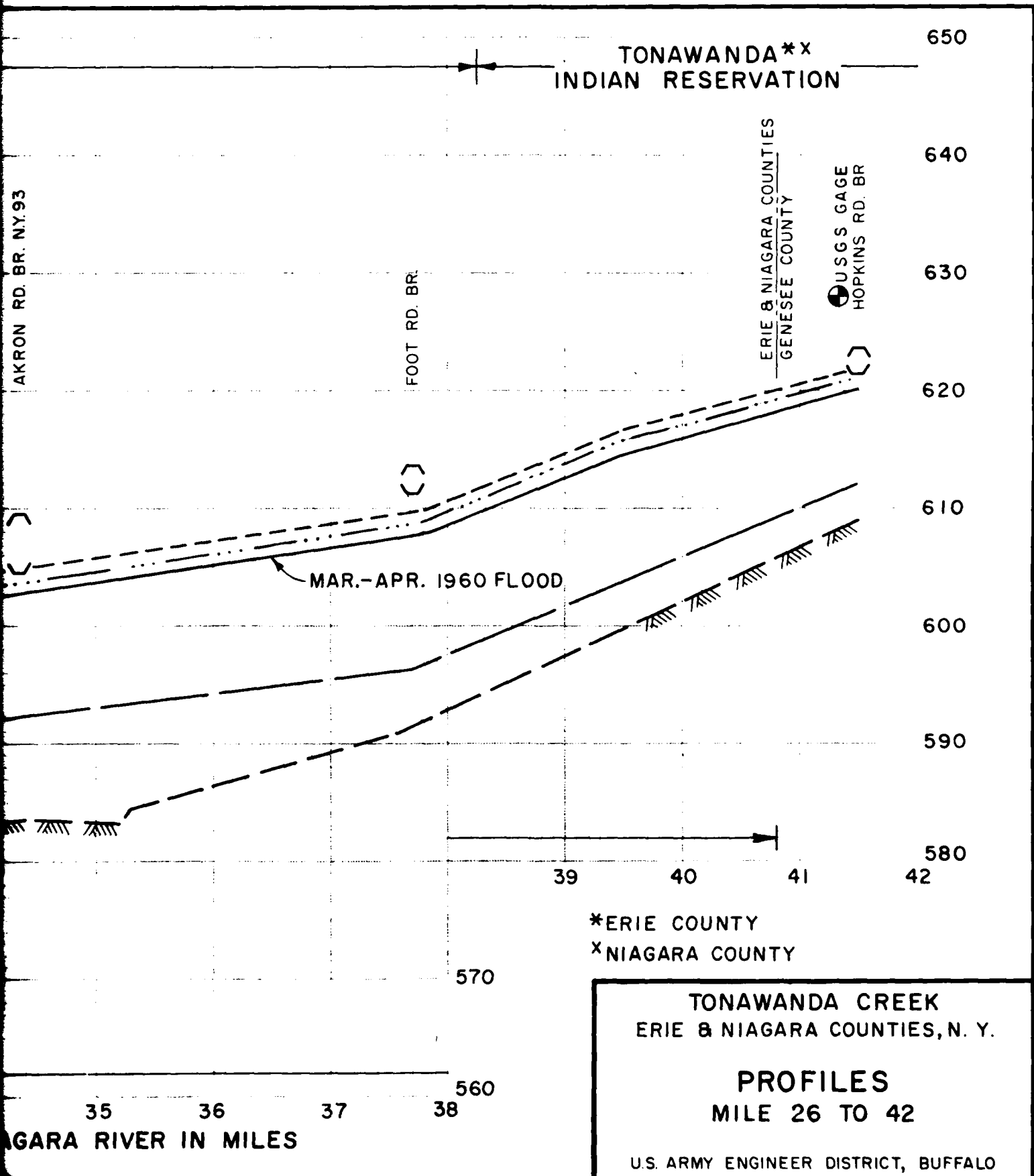
FROM MOUTH AT NIAGARA RIVER IN MILES

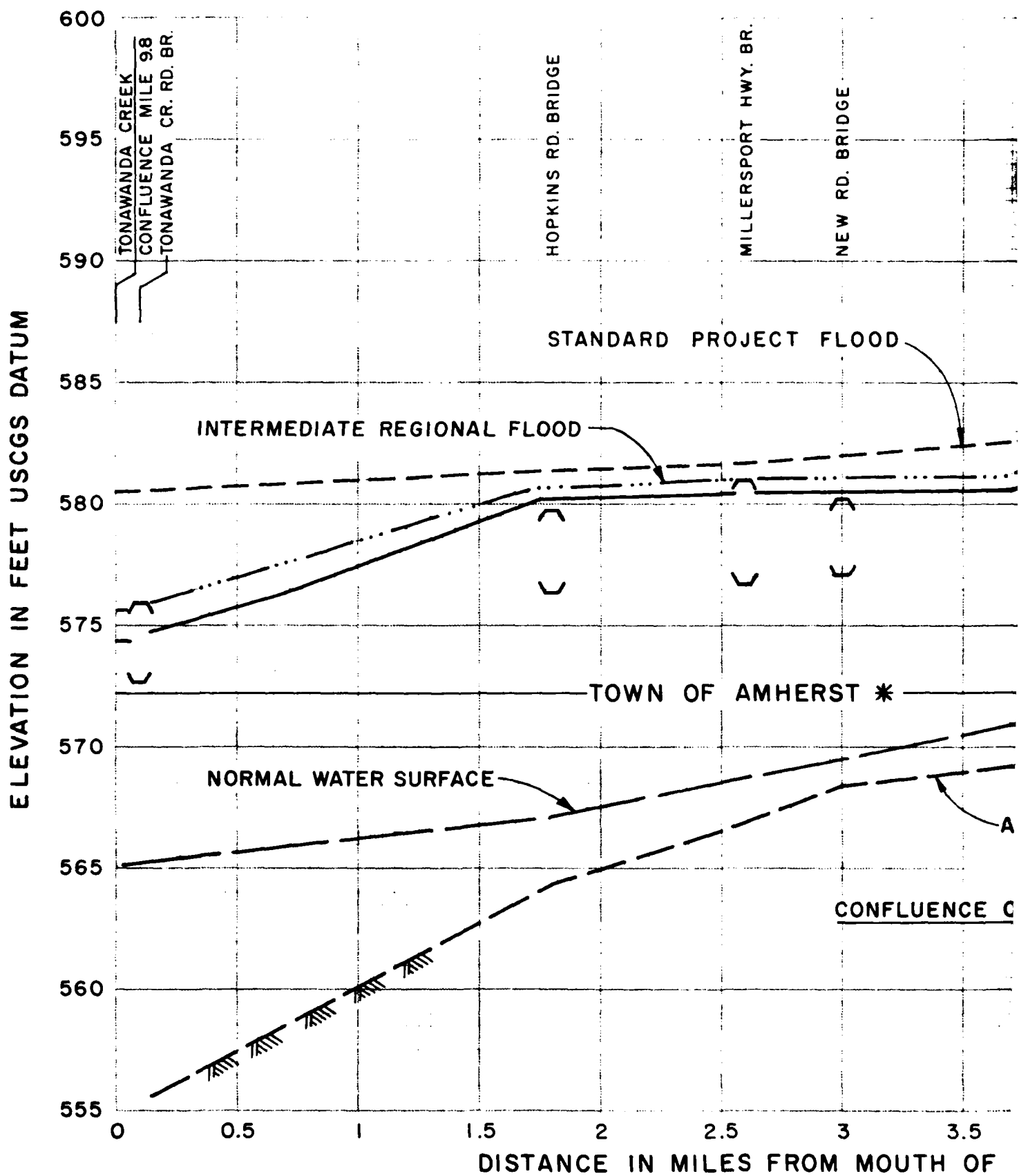
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*NIAGARA COUNTY

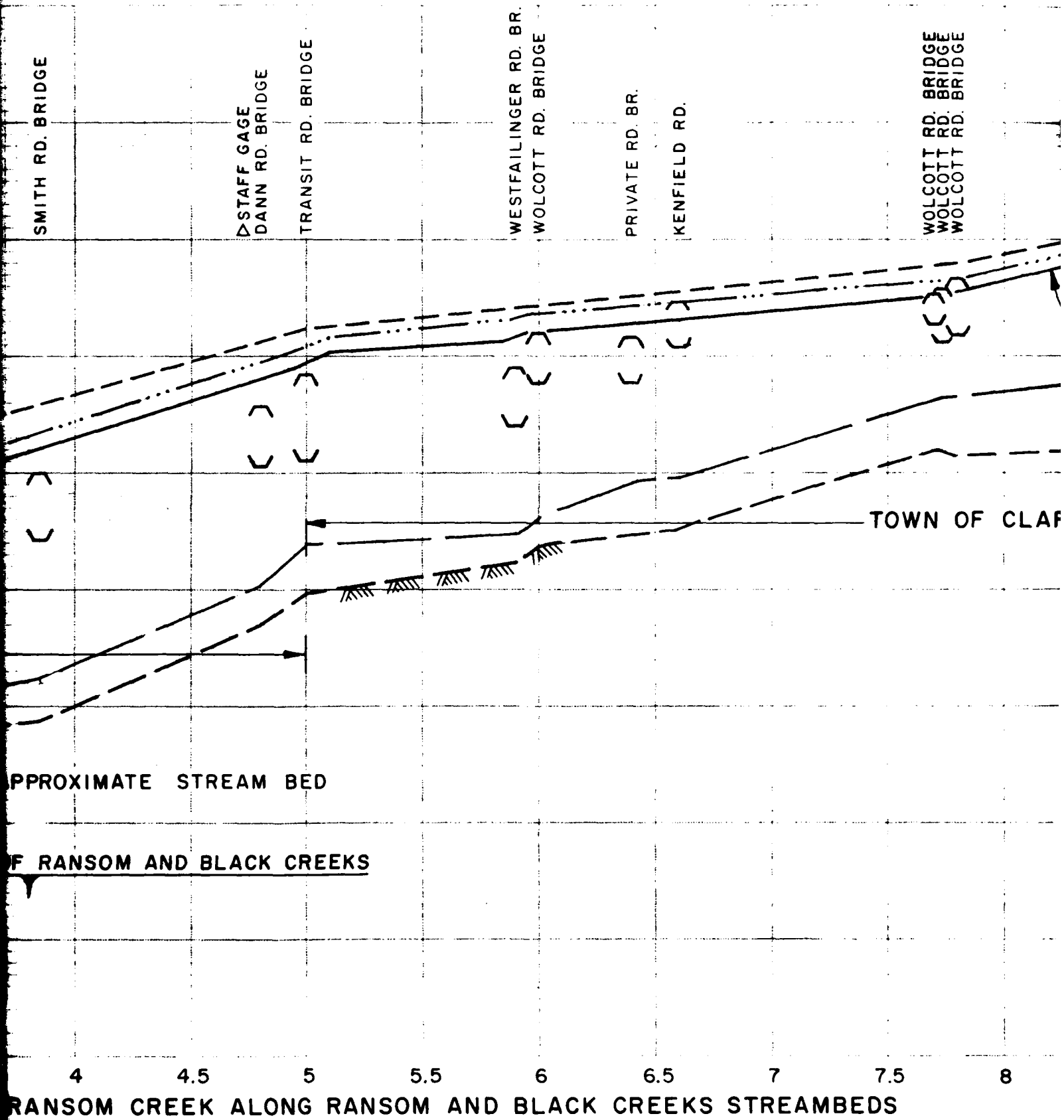
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ERIE & NIAGARA

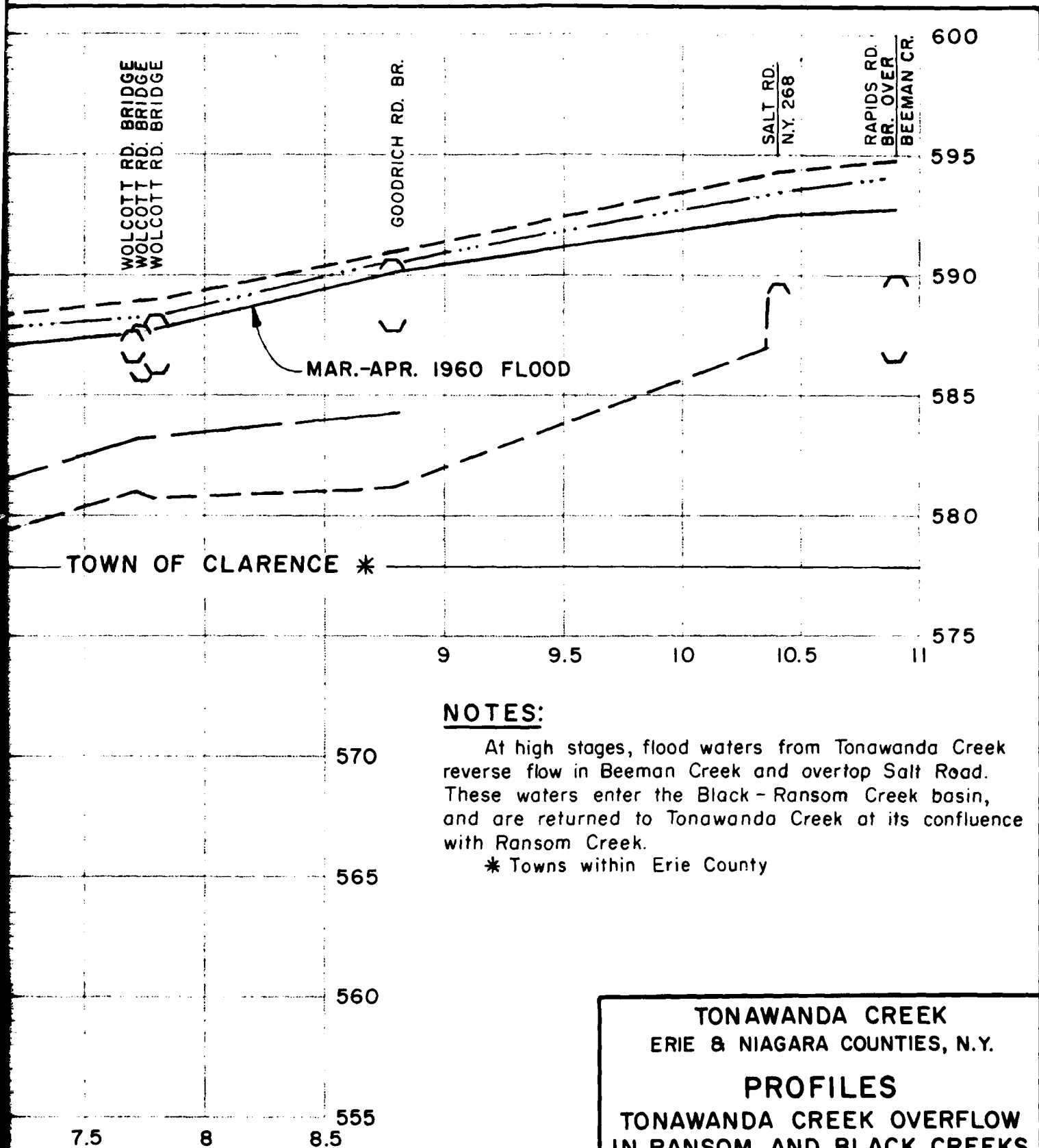
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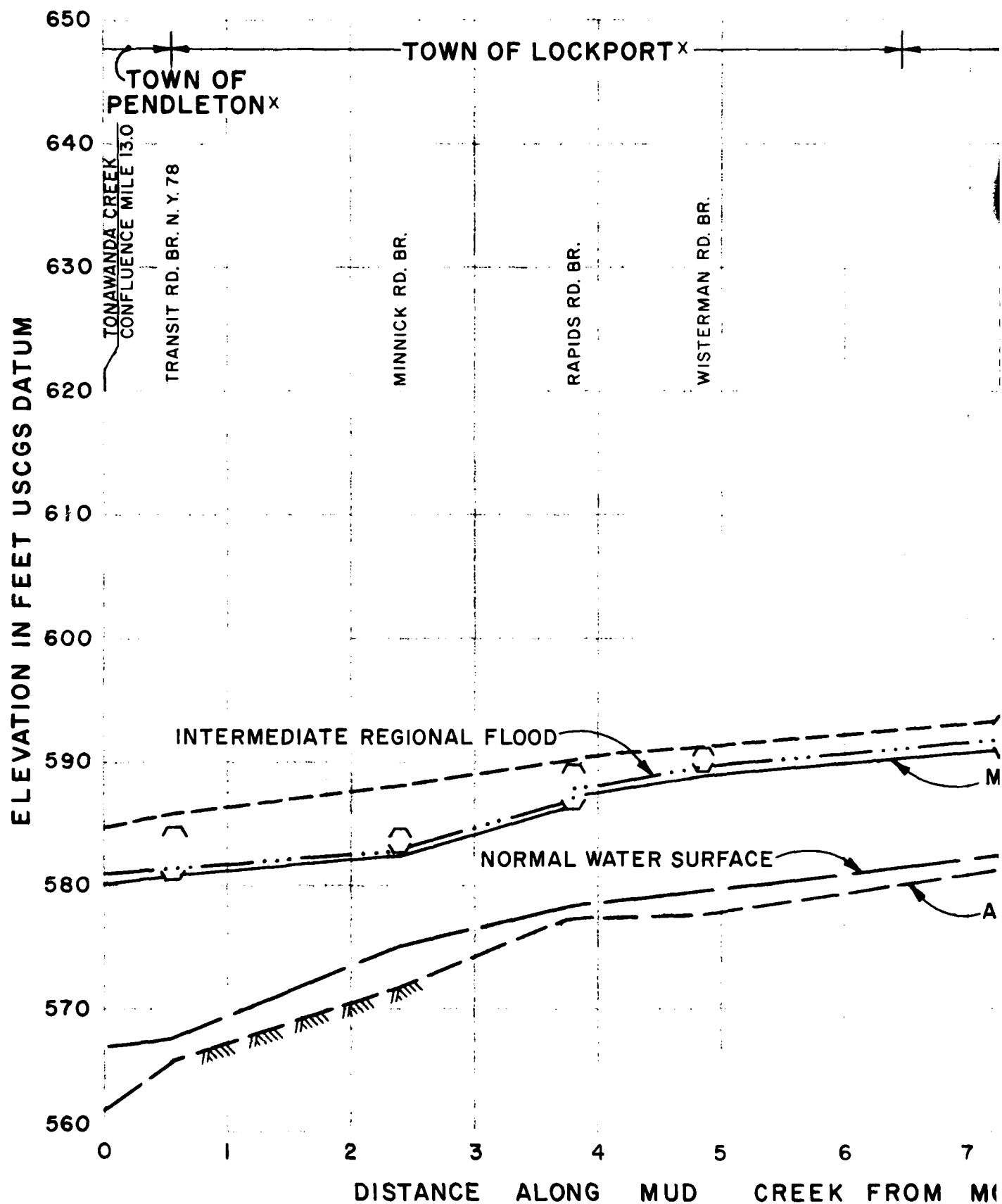
At high stages, flood waters from Tonawanda Creek reverse flow in Beeman Creek and overtop Salt Road. These waters enter the Black - Ransom Creek basin, and are returned to Tonawanda Creek at its confluence with Ransom Creek.

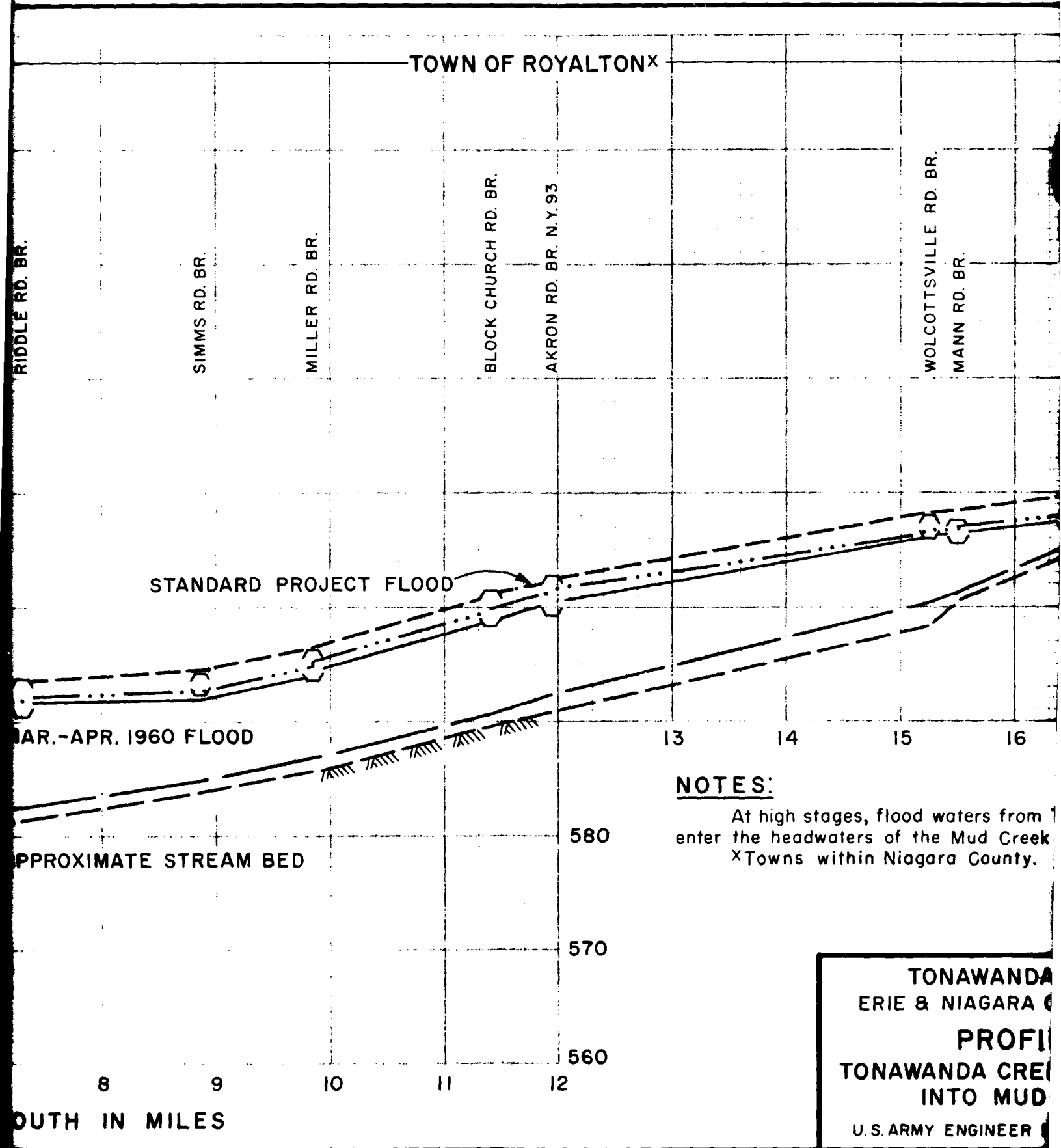
* Towns within Erie County

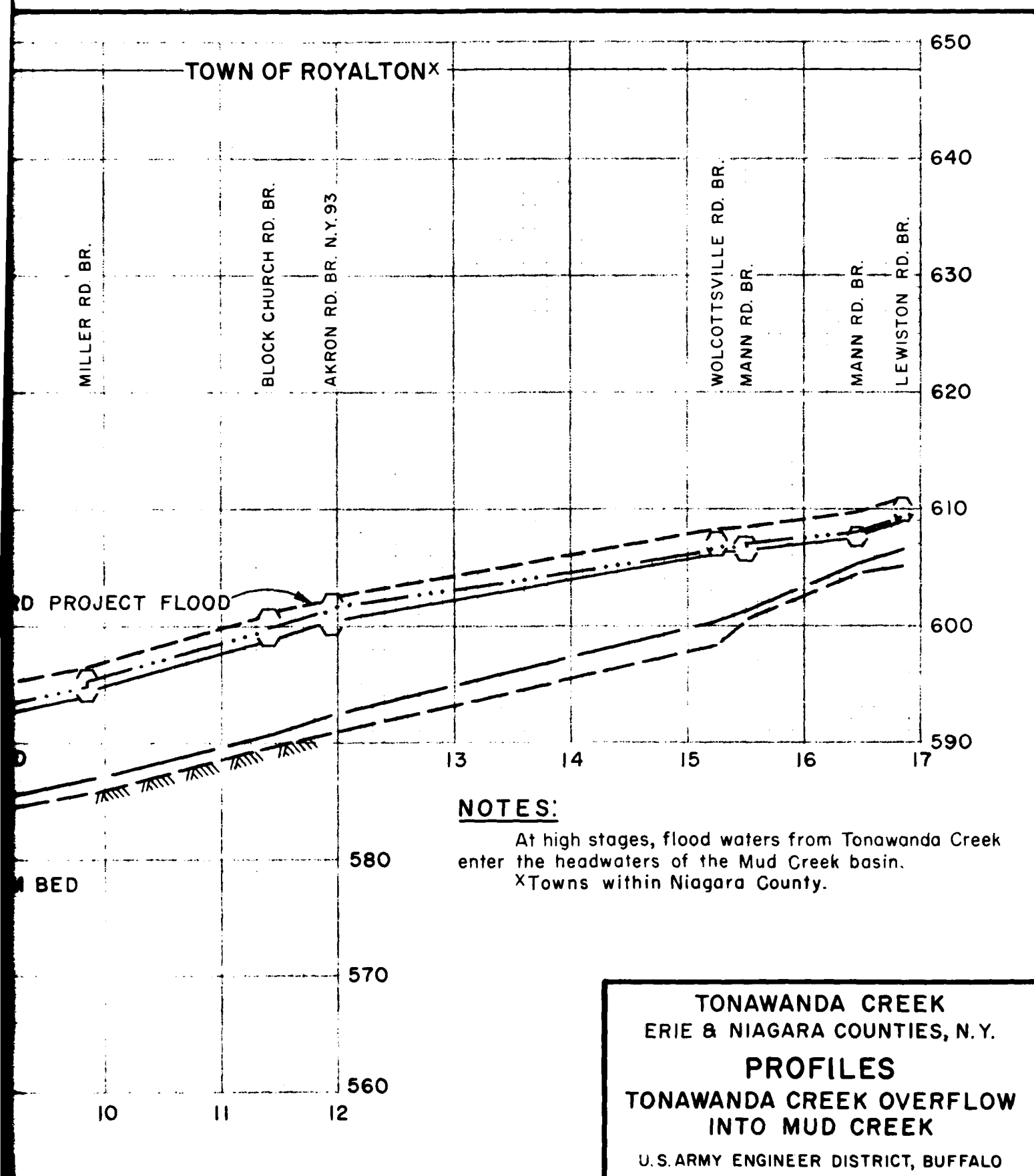
TONAWANDA CREEK
ERIE & NIAGARA COUNTIES, N.Y.

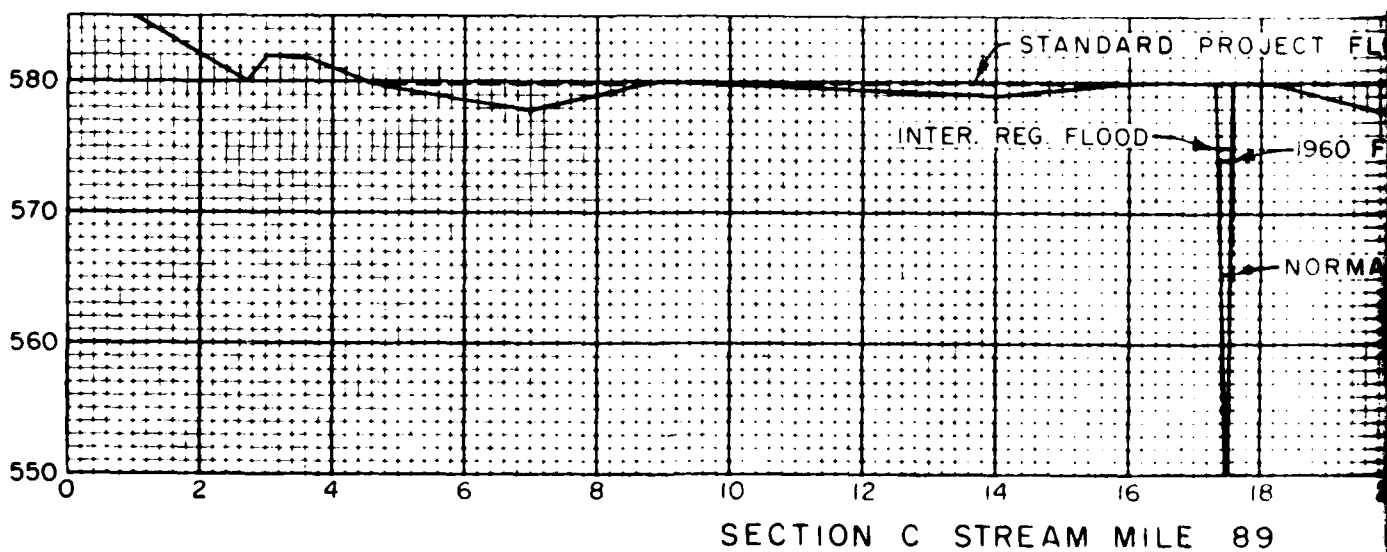
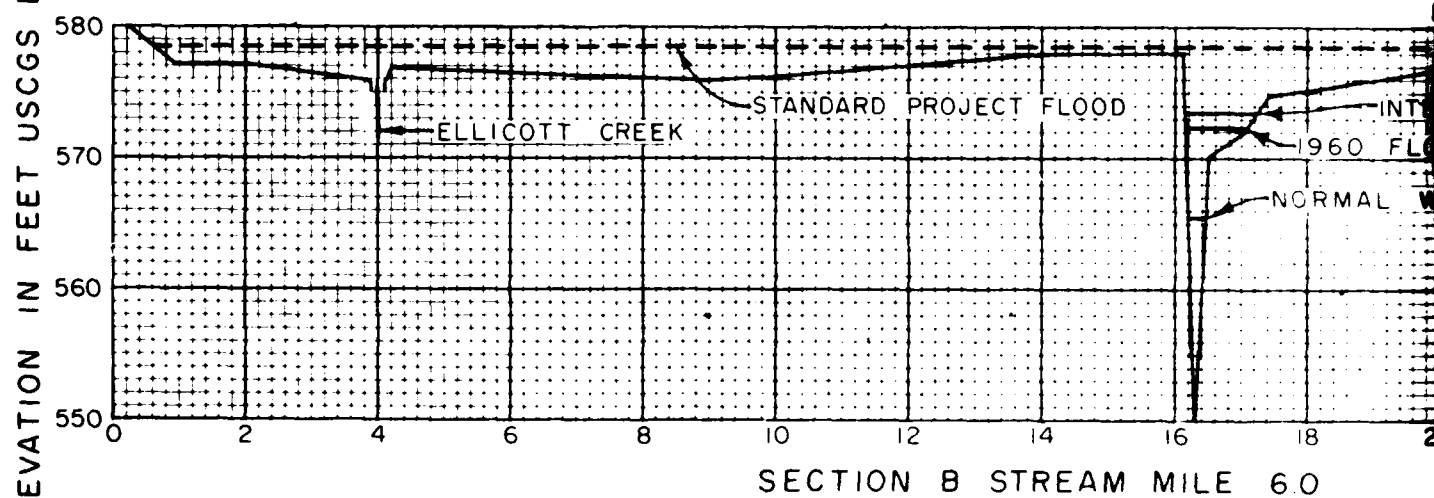
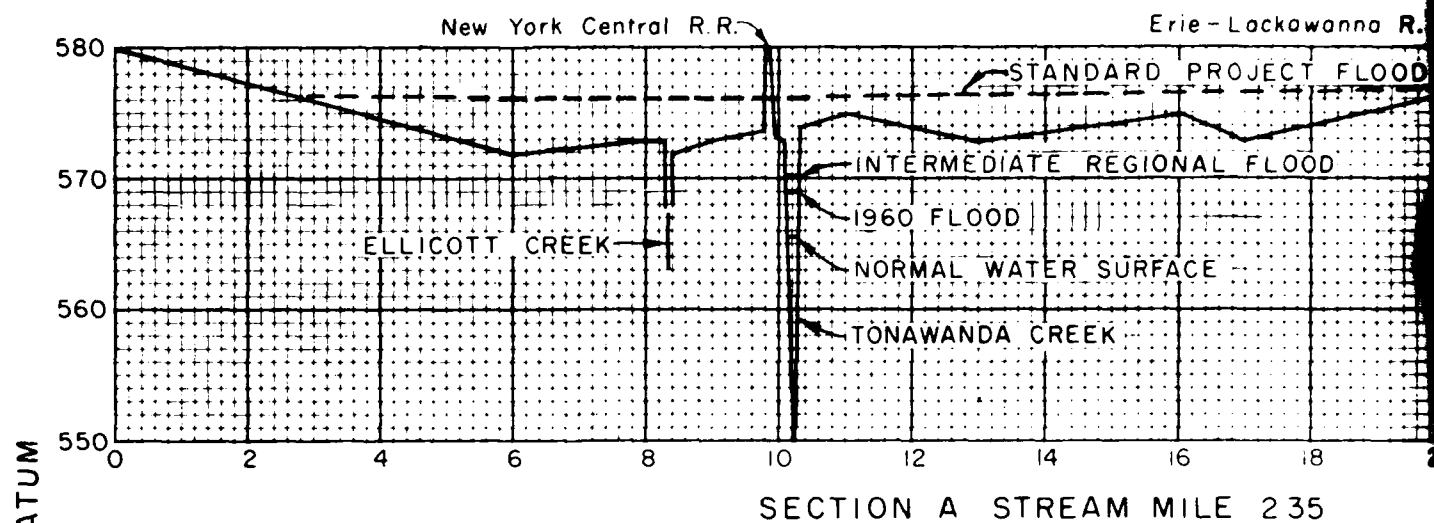
PROFILES
TONAWANDA CREEK OVERFLOW
IN RANSOM AND BLACK CREEKS

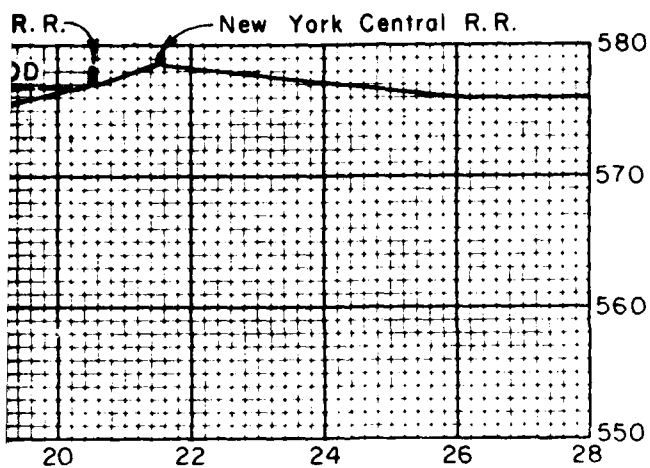
U.S. ARMY ENGINEER DISTRICT, BUFFALO











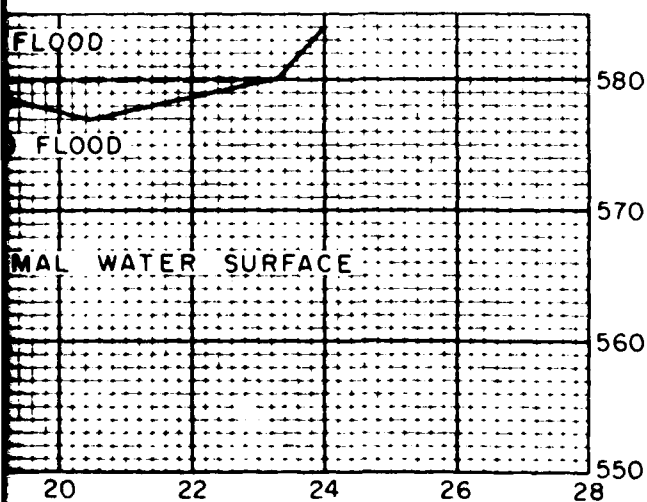
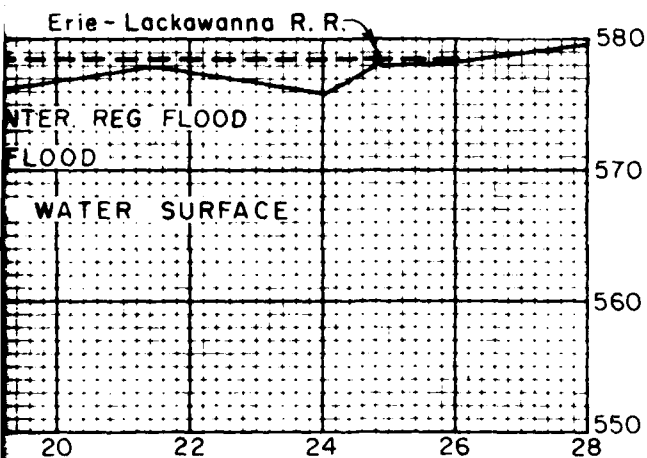
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HORIZONTAL DISTANCE IN THOUSANDS OF FEET.

VALLEY CROSS SECTIONS ARE BASED ON U.S.

GEOLOGICAL QUAD. MAPS AND OTHER AVAILABLE INFORMATION.

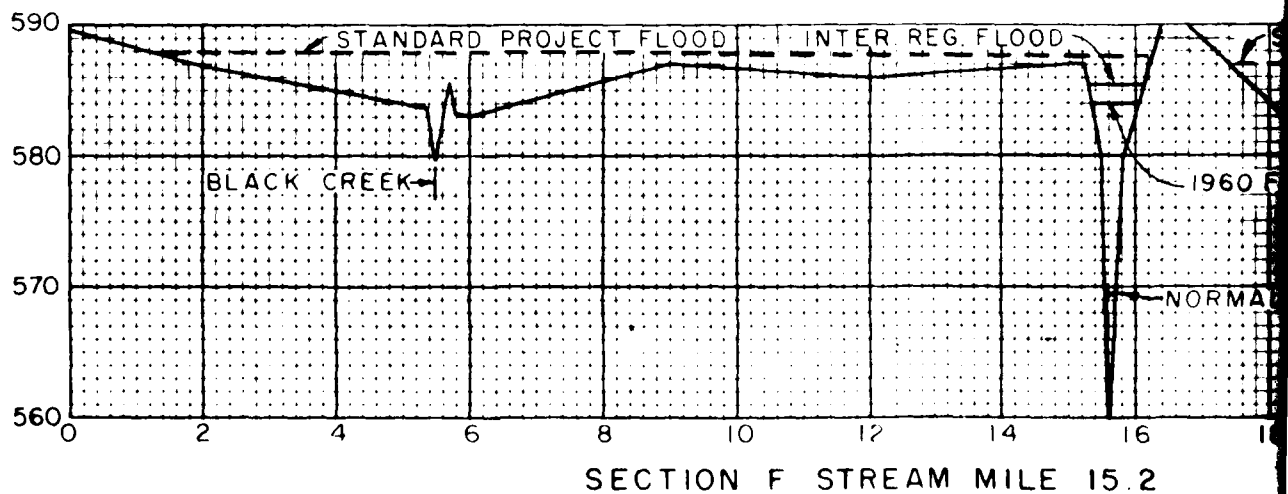
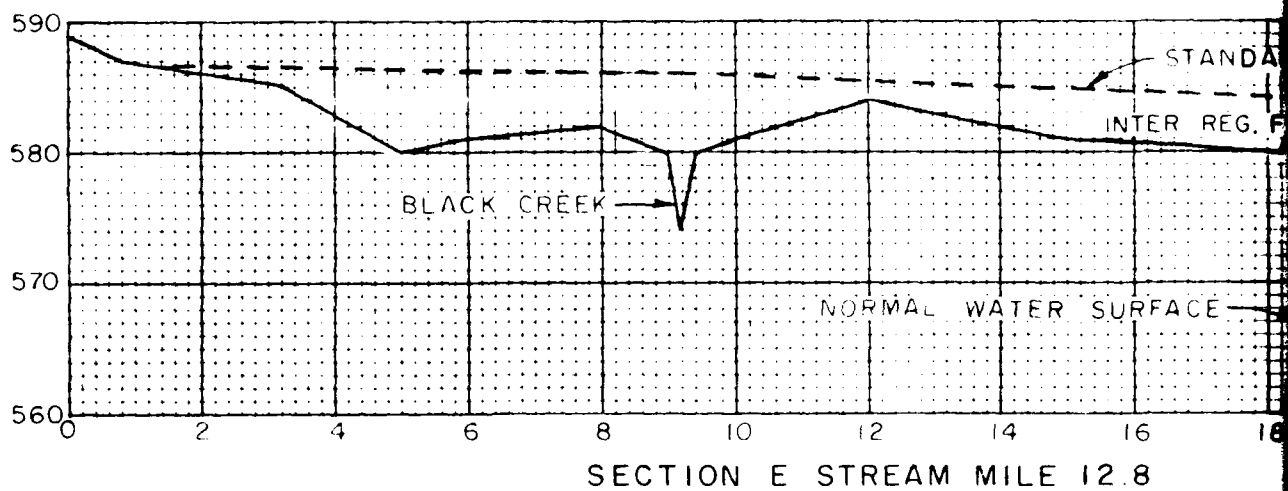
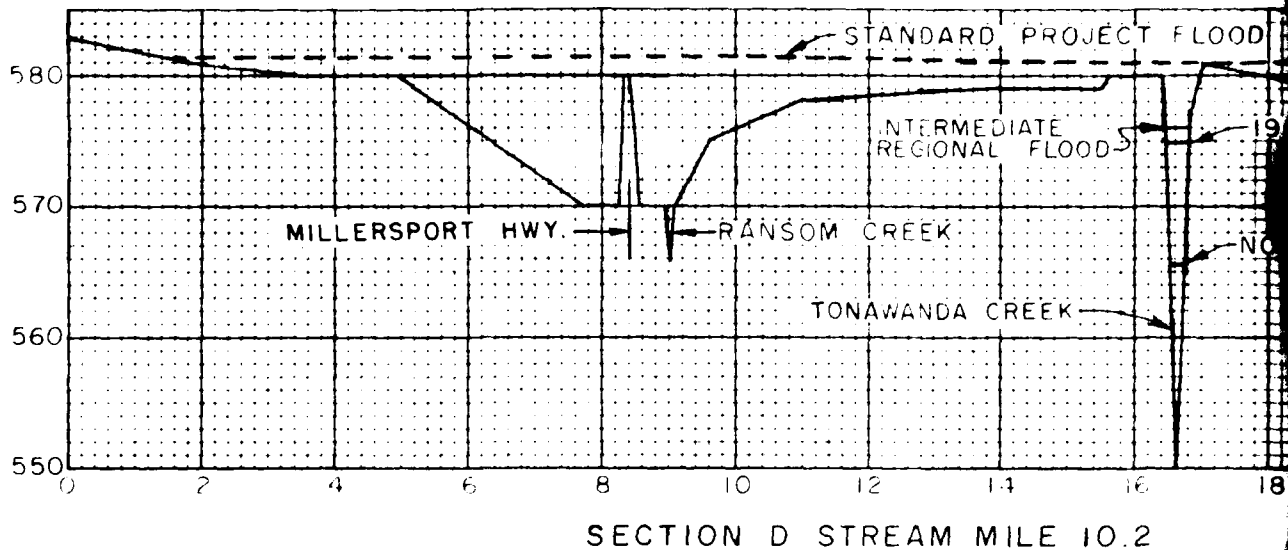
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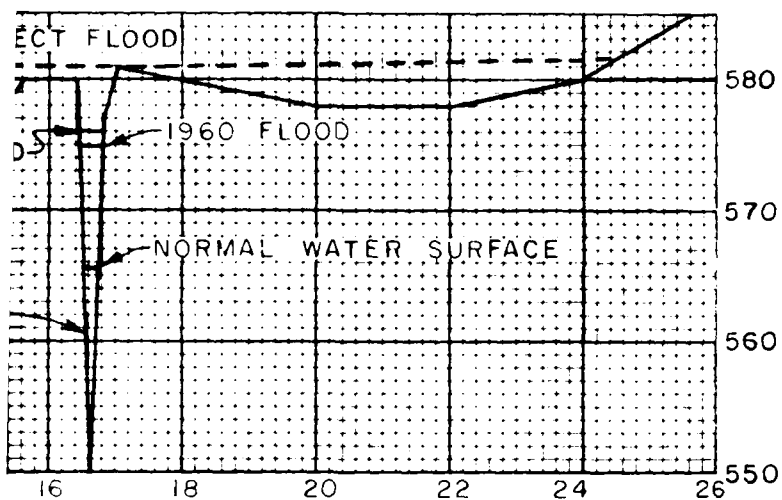


**TONAWANDA CREEK
ERIE & NIAGARA COUNTIES, N.Y.
VALLEY CROSS SECTIONS
A, B AND C.**

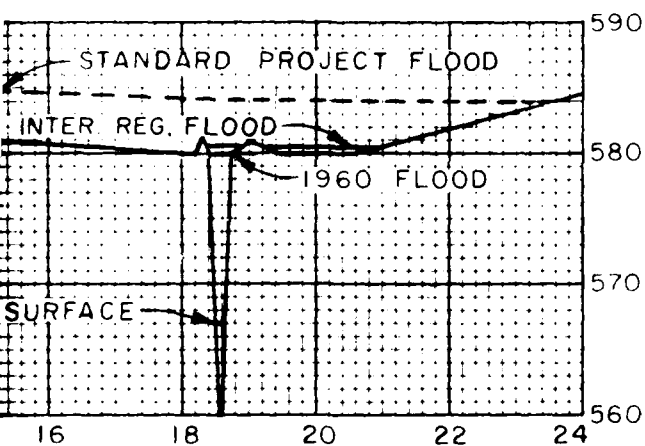
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ELEVATION IN FEET USCGS DATUM

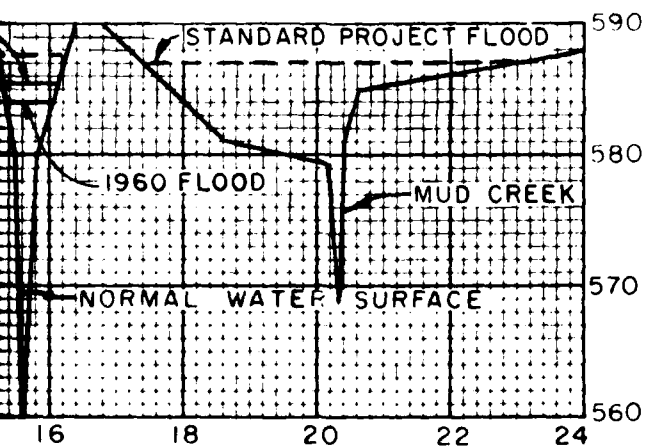




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HORIZONTAL DISTANCE IN THOUSANDS OF FEET.

VALLEY CROSS SECTIONS ARE BASED ON U.S.

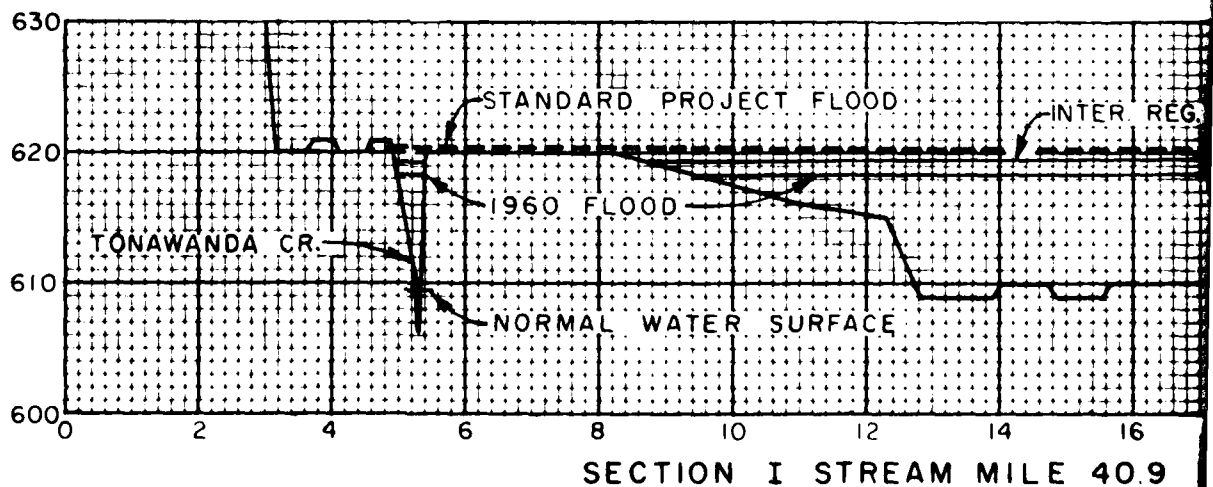
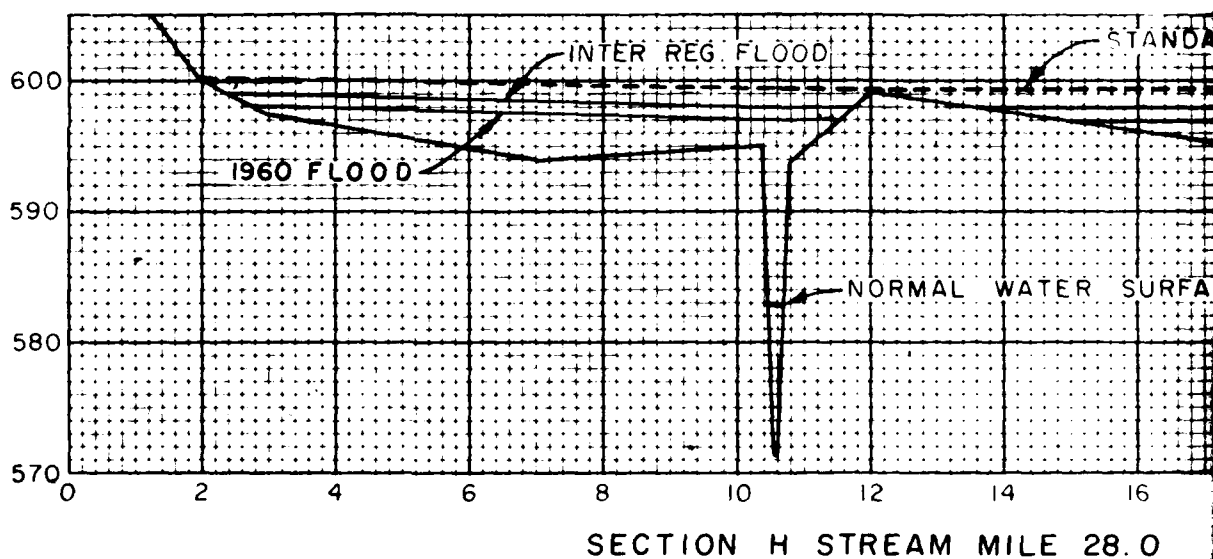
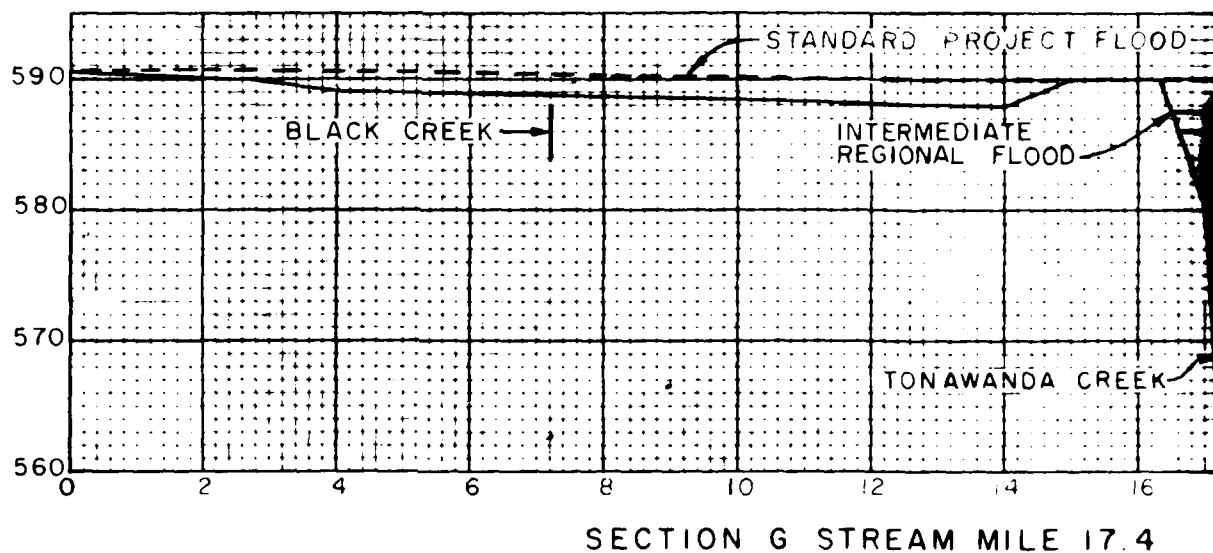
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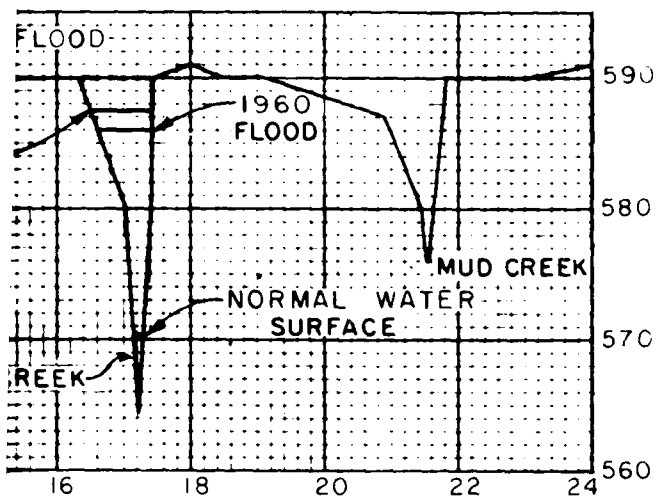
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**TONAWANDA CREEK
ERIE & NIAGARA COUNTIES, N.Y.
VALLEY CROSS SECTIONS
D, E AND F**

U.S. ARMY ENGINEER DISTRICT, BUFFALO

ELEVATION IN FEET USCGS DATUM





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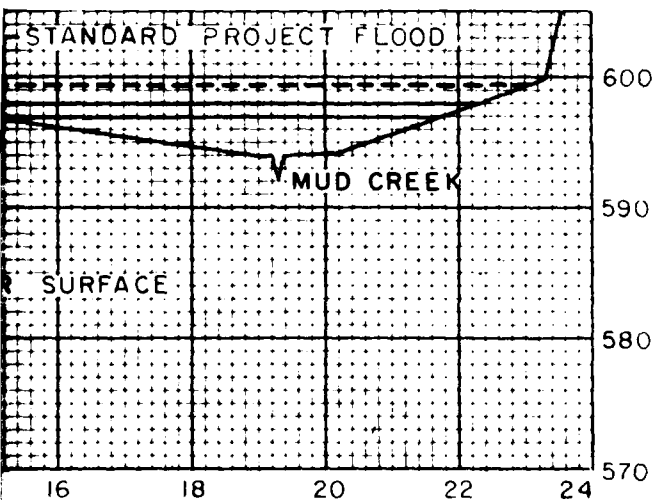
HORIZONTAL DISTANCE IN THOUSANDS OF FEET.

VALLEY CROSS SECTIONS ARE BASED ON U.S.

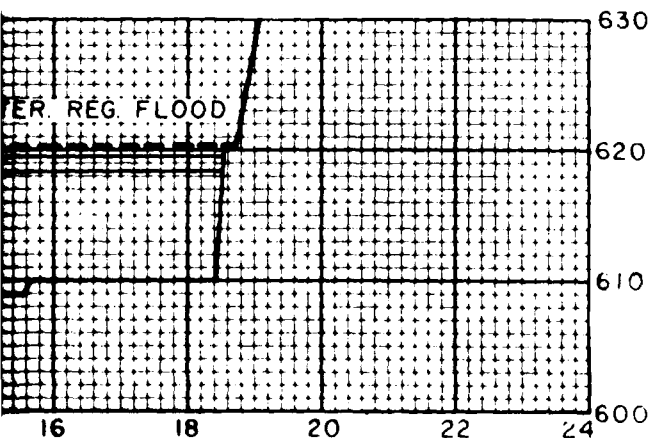
GEOLOGICAL QUAD. MAPS AND OTHER AVAILABLE INFORMATION.

VALLEY CROSS SECTIONS ARE LOOKING DOWNSTREAM AND ARE LOCATED ON PLATES 6 & 7.

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**TONAWANDA CREEK
ERIE & NIAGARA COUNTIES, N.Y.
VALLEY CROSS SECTIONS
G, H AND I**

U.S. ARMY ENGINEER DISTRICT, BUFFALO